THE STUDENT'S MANUAL

OF

COMPARATIVE ANATOMY,

AND

GUIDE TO DISSECTION.

DESIGNED FOR THE USE OF SCHOOLS AND OF JUNIOR STUDENTS
IN THE UNIVERSITIES.

PART I.

MAMMALIA.

(ANATOMY AND DISSECTION.)

BY

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PART I.

MAMMALIA.

(ANATOMY AND DISSECTION.)

ERRATA.

Page 6, line 5, *for* Proboscedia, *read* Proboscidea.
„ 16, „ 11 from bottom, *for* Phascochæres, *read* Phacochærus.
for Dycoteles, *read* Dicotyles.
„ 11, „ 3, *for* Phascolomydæ, *read* Phascolomidæ.
for Hysiprimmus, *read* Hypsiprimnus.
„ 24, „ 15, *for* post-scapalar, *read* post-scapular.
„ 39, note, *for* aromion, *read* acromion.
„ 53, note, *for* Didelphydæ, *read* Didelphidæ.
„ 55, line 13, *for* Phascolomyidæ, *read* Phascolomidæ.
„ 81, „ 7, *for* $i\,\frac{1\,.\,1}{1\,.\,1}$, *read* $i\,\frac{1 \text{ or } 2\,.\,1 \text{ or } 2}{2\,.\,2}$.
„ 85, „ 10, *for* Hypsiprininus, *read* Hypsiprimnus.
„ 85, „ 22, *for* Ornithorhynchus, *read* Ornithorhyncus.
„ 88, „ 7, *for* Arthodactyla, *read* Artiodactyla.
„ 141 „ 7 from bottom, *for* reptum, *read* septum.
„ 146 „ 9 from bottom, *for* occuli, *read* oculi.
„ 159 „ 6 from bottom, *dele* pair of.
„ 160 „ 5, *for* of each pair of, *read* of the.
„ 168 „ 4 from bottom, *add* in Man *after* temporal bone.
„ 181 „ 2 from bottom, *for* clavide, *read* clavicle.
„ 182 „ 2, *insert commas after* syringe *and* made.
„ 188 „ 4, *for* rena *read* renal.
„ 235 „ 2 from bottom, *for* Glasserian *read* Gasserian.

PREFACE.

In preparing the following short outline of the Anatomy of the Mammalia, and of the Methods to be pursued in investigating (*a*) the arrangement of parts in the Mammalian Body, and (*b*) the special construction of certain of these parts, *e.g.* the Heart, Brain, Eye, and Cerebral Nervous System, frequent reference has been made to, and almost verbatim extracts taken from, the following books and papers, *viz.*:—

Carpenter. Principles of Comparative Physiology.
Cobbold. Cyc. Anatomy and Physiology,—*art.* Ruminantia.
Ellis. Demonstrations of Human Anatomy.
Flower. Osteology of the Mammalia, in Journal of Anatomy and Physiology, 1867 and 1869 (Mammalian Teeth). In Philosophical Transactions, 1867 (Marsupial Teeth), and 1865, p. 633 (Marsupial and Monotreme Brain).
Gray. Human Anatomy.
Gulliver. Proceedings of Zoological Society, March, 1870 (Striated Muscular Fibre of Œsophagus).
Hewson. Sydenham Society, 1846 (Blood Corpuscles).
Hulke. British Medical Journal, September, 1870 (Eye).
Huxley. Elements of Comparative Anatomy, 1864.
Mayer. Anat. Untersuchungen über das Auge der Cetaceen.
Marshall, J. Phil. Trans., 1850, p. 133 (Azygos Veins).
Milne Edwards. Leçons sur la Physiologie.
Owen. Comparative Anatomy and Physiology of Vertebrata, Vols. ii. and iii.
Parker. Shoulder Girdle.
Quain. Human Anatomy.
Rapp. Cetaceen.
Rolleston. Forms of Animal Life.
Rutherford. Quarterly Journal of Microscopical Science, Jan. 1872 (Preparation of the Retina).

Strangeways. Veterinary Anatomy.
Turner (Edinburgh). In Natural History Review, 1862 (Orbit).
Van der Hoeven. Handbook of Zoology, Vol. ii.
Wagner. Comparative Anatomy of Vertebrata.
Waterhouse. Natural History of Mammalia.

In making such extracts, it has been the object of the Author to present to the Student, within the limits of a few pages, a condensed summary of the salient points to be noted in studying the Mammalian organism; in other words, to point out shortly, and in one handy volume, the essence of matter spread over many pages in many different volumes. Although in some respects the opening pages of the present volume may bear upon their surface the impress of a species of "technical cram book"; it is hoped that the concluding pages, in which a series of Dissections are proposed to the Student, may in some measure erase such an impression, from the fact that in the pursuit of such practical study as there put out the Student is so brought face to face with many of the structures treated of in the former part of the volume that they cannot any longer remain to him mere abstract idealities, but must become well defined, tangible realities, impressed upon his mind as things seen.

In conclusion, the Author would express his sincere thanks to Mr. C. Robertson, Demonstrator of Anatomy and Physiology in the University Museum, Oxford, for his untiring supervision of the proof-sheets passing through the press, and for his many valuable hints and suggestions as the work proceeded.

3 Park Street, Oxford,
October, 1872.

CONTENTS.

CLASSIFICATION.

THE Class MAMMALIA has been grouped with the Sauroids, or Sauropsida, for that they both lack apparatus for breathing air when dissolved in water. They have been hence termed *Abranchiate Vertebrata.*

By virtue of being a Vertebrate, the Mammal is possessed of well-marked characters, separating it from other Non-Vertebrate living creatures (*e.g.* an endo-skeleton, &c., see the Introduction): and inasmuch as it is an air-breathing Vertebrate, the ultimate sub-divisions of the appendages of its scapular and pelvic arches will be found not to exceed five.

This Class includes fifteen

ORDERS:

I. BIMANA	VI. SECTORIALIA	XI. CETE
II. QUADRUMANA	VII. PROBOSCIDIA	XII. SIRENIA
III. INSECTIVORA	VIII. PERISSODACTYLA	XIII. IN-ENAMELLATA
IV. CHEIROPTERA	IX. HYRACOIDEA	XIV. MARSUPIALIA
V. RODENTIA	X. ARTIODACTYLA	XV. MONOTREMATA

N.B.—For examples see the annexed Table.

The Orders I.—XIII. inclusive form the Sub-class

"*PLACENTALIA.*"

The Orders I.—VI. inclusive form part of a great section of the Mammalia which are possessed of claws, and are thence termed

"*UNGUICULATA.*"*

I. In the Order BIMANA, is included the genus Homo alone; set apart as possessed of,—hands (thumb opposable) to

* The remaining three Orders which come under this wide Section are the *In-enamellata*, *Marsupialia*, and *Monotremata*, treated of later on.

the anterior extremities only,—special modifications of the pelvic arch and limbs, and muscles thereto attached, whereby the erect position is maintained,—the highest development of brain, and,—no muzzle.

II. In the Order QUADRUMANA, the hand (innermost digit opposable) is present on the posterior extremities; and the muzzle is more or less elongated. Three well-defined Groups are comprised in this "Order," *viz.*:

1. Catarrhina or Simiadæ.	2. Platyrrhina.	3. Strepsirrhina or Lemuridæ.

which are divided into two

Sub-orders:

First, SIMIADÆ, or Monkeys, including the two first groups.
Second, LEMURIDÆ, synonymous with the third group.

The *Catarrhina* have the nostrils oblique and approximated below, and opening above and behind the muzzle. They are restricted to the Old World. This Sub-order includes the Anthropomorphous (tail-less) Apes, Baboons, &c.

The *Platyrrhina* have the nostrils simple, sub-terminal, and wide apart; and the tail generally prehensile. They are peculiar to South America.

The *Strepsirrhina* have curved or twisted terminal nostrils. They are confined to Africa, Madagascar, and India. In this Sub-Order, the *Cheiromys* (Aye-Aye), is included, which was classified by Cuvier among the Rodentia.

III. Among the INSECTIVORA, all of which have molar teeth, bristled with cusps, the *Galeopithecidæ* find a place: these have by various authors been assigned to the Cheiroptera (Cuvier), or to the Lemuridæ of the Quadrumana. The latest authorities, however, Professors Owen and Huxley, classify them as here given. The other members of this Order are the *Erinaceidæ*, which have the body covered with prickles instead of hairs; the *Soricidæ*, with close fur, pointed muzzle and scaly tail; and the *Talpidæ*, which have amazingly powerful fore-feet, and lack the organ of vision.

IV. The distinctive character of the CHEIROPTERA* consists in a delicate leathery membrane, which, uniting the four long fingers, that radiate widely from the wrist, and filling up the space between them and the side of the body, has the appearance of a wing.

The Four *Families* composing this Order are

1. The *Vespertilionidæ*, or true bats; 2. the *Rhinolophidæ*, or horse-shoe bats, with a leaf-like membrane on the nose; both chiefly insectivorous; 3. the *Phyllostomidæ*, or Vampyres; and, lastly, 4. the *Pteropidæ* or Roussettes, with head of dog-like form, both of which are chiefly frugivorous.

V. The RODENTIA† are characterised by two large and long curved incisors in each jaw, separated by a wide interval from the molars, and the divided upper lip.

This Order comprises Eight *Families:*

1st, the *Leporidæ*, at once distinguished from all the other Rodentia by the possession of a small incisor behind each normal one. 2nd, the *Cavidæ*, in which the tail is either rudimentary or entirely wanting. 3rd, the *Hystricidæ*, distinguished by the spiny quills covering their bodies. 4th, the *Chinchillidæ*, with large broad ears and tufted tail. 5th, the *Castoridæ*, distinguished from all other Rodents by their horizontally flattened tail, of a nearly oval form, and covered with scales. 6th, the *Muridæ*, which have only four toes on the anterior feet, and a sort of wart to represent the thumb, and a long scaly tail. 7th, the *Myoxidæ*, intermediate between the preceding more or less mouse-like animals and the true squirrels. And, lastly (8), the *Sciuridæ*, which may be recognised by their very compressed lower incisors and by their long bushy tail. The Cheiromys, or Aye-Aye, classified by Cuvier among the Rodents, is now considered to belong rather to the Lemuridæ (Quadrumana).

* χείρ, hand: πτερόν, wing.

† Synonymous with the Glires of Linnæus.

VI. The species of the Order SECTORIALIA,* synonymous with the Order *Carnivora*, as restricted by Profs. Owen and Huxley, may be at once recognised by,—their four conical, curved, acute, canine teeth,—the gap between the incisors and canines in the upper jaw for the reception of the lower canine,—the molars either wholly trenchant or somewhat tuberculated, but never studded with sharp conical projections, and—in each molar series the *Dens Sectorius*.

This Order is divided into four

Sub-orders:

1. Digitigrada. 2. Semi-Plantigrada.
3. Plantigrada. 4. Pinnigrada.

1. The Sub-order Digitigrada includes the most typical members of the Order: those whose short toes alone are applied to the ground, and that walk on tip-toe.

Such are the *Families*

of 1. the *Canidæ*, in which the toes are all armed with non-retractile claws, and the tongue is soft and destitute of horny spines. 2. The *Felidæ*, which have retractile claws, and a tongue covered with small recurved prickles. 3. The *Hyænidæ*, with non-retractile claws (Canidæ), a prickly tongue (Felidæ), and a pouch beneath the anus (Viverridæ). 4. The *Viverridæ*, whose glandular oval pouch secretes the odorous civet.

2. The second Sub-order, the Semiplantigrada, is

synonymous with the *Family*

of the *Mustelidæ*; animals which apply a portion of the sole to the ground, but have the heel always raised: on account of the length of the body and shortness of the limbs they

* The term *Carnivora* as used by Linnæus included the Cheiroptera and Insectivora, as well as the so-called 'Carnivora proper,' and is synonymous with the *Carnaria* or *Carnassiers* of Cuvier. The Cheiroptera and Insectivora being now recognised as separate Orders, it seems inappropriate to use the same term to denote the remaining group alone. The name Sectorialia has been here applied having reference to the *Dens Sectorius*, or scissor tooth, found in the typical members of this Order.

move with a peculiar gliding character, and have been termed *Vermiformes* [? Vermin].

3. The third Sub-order, the PLANTIGRADA, in which the whole or nearly the whole of the hind foot forms a sole, and rests upon the ground,

contains Three *Families*:

1. The *Melidæ*.—The members of this family have been classified sometimes among the Viverridæ, sometimes among the Ursidæ (Linnæus). 2. The *Ursidæ*, which differ from all the preceding families in the nature of the molar teeth, which, although compressed in form, are furnished with tubercular crowns. And 3. The *Cercoleptidæ*, or Kinkajous, with very long prehensile tail, short muzzle, and slender extensile tongue.

4. In the last Sub-order, the PINNIGRADA, both fore and hind feet are short, and expanded into broad webbed paddles for swimming, the hinder ones being bound in with the skin of the tail.

It includes Two *Families*:

1. The *Phocidæ*, which have incisor teeth in both jaws, generally throughout life,—canines of moderate size, and—molars trenchant; and 2. *Trichœcidæ*, which lose most of their incisor teeth early,—have upper canines enormously developed, passing between the small canines of the lower jaw, and projecting below the chin, and—molars of conical form.

We now proceed to consider the purely vegetarian section of the Mammalian Class, which is characterised by having hoofs instead of claws, and is thence termed

"UNGULATA."

(Orders VIII.—X. inclusive.)

Cuvier divided his "sub-class" Ungulata into two Orders, which he named Pachydermata and Ruminantia, and placed

under the order Pachydermata the following three genera, *viz.* Proboscidea, Ordinaria (*e.g.* Sus and Tapirus), and Solidungula.

Modern classification has raised Cuvier's genus P. Proboscedia to rank as an Order, and has subdivided his genus P. Ordinaria into three; first, taking out those animals with an "Even" number of digits fully developed; and, secondly, taking out of the remainder, which of course have an "Odd" number of fully developed digits, the Hyracidæ. With the "Even" toed P. Ordinaria has been associated Cuvier's Ruminantia, to form the Order called Artiodactyla (ἄρτιος even, δάκτυλος digit). With his "Odd" toed P. Ordinaria has been grouped Cuvier's Solidungula, to form the Order called Perissodactyla (περισσός odd, uneven, δάκτυλος, digit). Lastly, the family of the Hyracidæ has been elevated to form the Order called Hyracoidea.

TABLE OF UNGULATA.

CUVIER'S ORDERS.			MODERN ORDERS.
Ruminantia		Ruminantia	ARTIODACTYLA
Pachydermata	ordinaria	even-toed = Omnivora	
		hyracidæ	HYRACOIDEA
		odd toed = Multungula	PERISSODACTYLA
	solidungula	Solidungula	
	proboscidea		PROBOSCIDIA

VII. The PROBOSCIDIA. The members composing this Order are characterised by the possession of two incisors, in the form of long tusks; and of a nose prolonged into a cylindrical trunk, flexible in all directions, highly sensitive, and terminated by a prehensile appendage like a finger. Herein are included only the *Family* of the *Elephantidæ*.

VIII. In the Order PERISSODACTYLA are included all those animals that have an unsymmetrical or odd number of toes in the hind feet always, and generally in the fore feet also. In the Tapiridæ, however, the fore feet are "even"

toed, being tetradactyle, but the digits are still unsymmetrical (*viz.*, inter se), for digit iii. is the largest and longest. If the species be horned, the horn or horns are placed on the median line of the head.

This Order is divided into two

Sub-orders :

1. Solid-ungulà. 2. Mult-ungula.

1. The Sub-order Solidungula is

synonymous with the single *Family*

of the *Equidæ*, characterised by having only one digit (iii.) completely developed in each foot; and having that digit enclosed at its extremity in an entire hoof.

2. The species included in the Sub-order Mult-ungula have all three toes to the hind feet, and also to the fore feet, with the exception above named (Tapiridæ). They are

divided into two *Families :*

1. The *Rhinoceridæ* have, springing from the upper surface of their muzzle, a single or double horn, composed of a solid mass of horny fibres, supported on a bony protuberance of the nose. When two horns are present, they are placed one behind the other, and the posterior horn is much shorter than the anterior. 2. The *Tapiridæ* have the nose produced into a short proboscis.

IX. The species of the Order HYRACOIDEA were long placed among the Rodentia, on account of their size: Cuvier placed them next to the Rhinoceridæ: Wagner made a separate group of the Pachydermata for their reception, which he termed "Lamn-ungula," for that the feet are furnished with flattened nails instead of hoofs. This Order

contains but a single *Family,*

the *Hyracidæ.*

X. The ARTIODACTYLA. The species comprised in this Order are characterised by having an even number of hoofed toes to each foot; sometimes four, *e.g.* Hippopotamus,

sometimes two, *e.g.* Camelopardalis Giraffa; and sometimes two functional and two rudimental, *e.g.* most Ruminantia. If the species be horned, the horns form one pair or two pairs; they are never developed singly, nor if there be two are they placed on the median line of the head.

The Order Artiodactyla readily divides into two

Sub-orders:

1. Omnivora. 2. Ruminantia.

The Sub-order Omnivora comprehends those species which Cuvier grouped together as the "even-toed Pachydermata Ordinaria," and of which he said, that they approximated the Ruminants in various parts of their skeleton, and even in the complication of the stomach, *viz.* the

Two *Families*

of the *Hippopotamidæ* and the *Suidæ.* Of these the species of the former have four toes, each terminated by a hoof to each foot; while the species of the latter have two hoofed toes functional, *i.e.* available for walking, and two* others, rudimental, placed at some little elevation on the back of the foot.

2. The Sub-order Ruminantia (the *Pecora* of Linnæus, and recognised by Aristotle as a natural Order, under the title *μηρυκαζοντα*), is one of the most distinctly circumscribed groups of Mammalia; one family alone, the Camelidæ, presenting any considerable exceptions to the general characters of the Sub-order; such as are,—the absence † of incisors in the upper jaw, and their replacement by a callous pad;—the likeness and approximation of the lower canines to the lower incisors;—the wide diastema anterior to the molar series;—the true molars marked as to their crowns with two double

* In Dicotyles the hind feet are said to have only three toes, one of the hinder ones being deficient.

† The *Camelidæ* have a single pair of incisors in the upper jaw; and lower canines, and incisors dissimilar.

crescents, the convexity of which is turned inwards in the upper and outwards in the lower jaw;—the stomach divided into four separate compartments: and—the 'cloven foot,' the two hoofs on each foot presenting a flat surface to each other, appearing as though a single hoof had been cleft. It is on the structure of the stomach that the faculty of returning food to the mouth for remastication depends, and it is from the name (rumen) given to the first of the compartments of the stomach that the title of this Sub-order is derived.*

The species comprised in this Sub-order may be divided into three well-marked groups, having regard to the presence or absence of horns, and the condition in which the horns when present exist,—*viz.*

Groups.

1. *Carenticornua.* 2. *Solidicornua.* 3. *Cavicornua.*

Of these, the first group, *Carenticornua* (*careo*, to be without; *cornua*, horns),

comprises the two *Families*

Camelidæ† and *Moschidæ*, of which all the component species are without horns; generally have a cleft tumid lip; and modifications of claws rather than hoofs.

All the other Ruminantia, at least of the male sex, have two *horns*, which may exist either as distinct bones uniting directly with the skull; or, as solid osseous developments arising from processes of the frontal bone; or, lastly, as sheaths of horny matter covering conical processes of the frontal bone.

In the Group *Solidicornua* (*solidus*, not hollow), are comprised those species which have dense osseous horns, *viz.*, those composing the

Two *Families*

Cervidæ and *Camelopardidæ*. The horns or *antlers* of the

* "*Ruminatio* dicta est a *rumine* eminente gutturis parte, per quam demissus cibus a certis revocatur animalibus." Serv. Virg. E. vi. 54.

† See note supra.

Cervidæ are deciduous, and with but a single exception, that of Rangifer (Reindeer) are possessed only by males. The horns of the Camelopardidæ, on the contrary, are permanent, and covered with a hairy skin.

The *Cavicornua* (*cavus*, hollow), the last Group of this Sub-order, is

synonymous with the *Family*

of the *Bovidæ*. In these animals the prominences of the frontal bones are covered each with an elastic sheath, or hollow horn, formed as it were of agglutinated hair, which continues to increase by layers during life. The prominence which the horn envelopes grows with it during life, and is not deciduous.

We propose now to consider that group of animals which, as being devoid of hind limbs, possessed of pectoral limbs only in the form of fins, and having the posterior part of the body flattened out into a horizontal* caudal fin, were termed by Cuvier

Mammalia MUTILATA.

This Sub-class (of Cuvier) contained one Order termed Cetacea, and this again two Genera; 1. The C. Herbivora, represented by the Dugong and cogeners, 2. The C. Ordinaria, or Blowers, represented by the Whale, &c. Modern classification has elevated these two genera each to rank as an Order. Some Zoologists have retained the name "Cetacea" for one of these Orders, using it to denote the C. Ordinaria alone, thereby introducing confusion. To avoid this, the term CETE has been here used instead, to designate the Order synonymous with Cuvier's C. Ordinaria. The term SIRENIA has been adopted as the "Order"-name, synonymous with Cuvier's genus C. Herbivora.

* Fish have the tail fin vertical.

XI. The species included by the modern Order CETE* are either edentulous† or Monophyodont; and all have the external nostrils, spiracles, or blow-holes, situated on the top of the head. They may be

divided into Three *Families.*

1. The *Balænidæ,* or true Whales, in which the teeth are deficient,† and the two sides of the upper jaw, furnished with thin transverse serrated laminæ, termed baleen or whalebone. 2. The *Physeteridæ,* or Sperm Whales, which have no baleen plates in the palate, nor teeth in the upper jaw, except in a very rudimentary condition. The superior portion of the enormous head consists of cavities filled with an oil which solidifies by exposure, called spermaceti. 3. The *Delphinidæ,* which always have one or more teeth in the upper jaw.

XII. The species included by the order SIRENIA have teeth of different kinds, are Diphyodont, and have nostrils situated at the upper fore part of the snout. In this order there are

only Two *Families.*

1. The *Rhytinidæ,* now extinct, are said to have had no true teeth, but only a pair of bony plates, placed anteriorly, on the palate and lower jaw. 2. The *Manatidæ* are always furnished with molar teeth.

The three following Orders complete the "Unguiculata."

XIII. The Order IN-ENAMELLATA‡ (teeth devoid of

* In the Linnæan classification the term Cete was used of the same Group of animals as that to which it is here applied.

† In the adult.

‡ The term In-Enamellata has been here adopted in order to avoid that extreme confusion which has arisen from employing, in different schemes of classification, one and the same term to denote quite distinct aggregations of families. When Cuvier entitled his sixth order of Mammalia "Edentata" he did so having regard to certain groups of animals which were possessed in common of this negative character alone, *viz.* that they lacked teeth in the fore part of their jaws. With him the Order Edentata connoted the E. Tardigrada (*e.g.* Bradypus);

enamel) is synonymous with Owen's Bruta, or Huxley's Edentata, and

includes Three *Families*.

1. The *Edentula* (synonymous with the Myrmecophagidæ), are all devoid of teeth, and have a highly protrusible tongue almost entirely composed of annular muscles. 2. The *Dasypodidæ*, which have numerous simple unenamelled teeth, and the body covered with bony plates, arranged in the middle in transverse bands (distinguishing them from the Manis, or Scaly Anteater). 3. The *Bradypodidæ*, which also have teeth, but they are devoid of true enamel, and are never replaced by a second series*: the members of this family are almost unique in having the fore legs much longer than their hind ones.

The two next Orders compose the Section of

IMPLACENTAL MAMMALIA.

XIV. The species comprised in the Order MARSUPIALIA have the so-called "Marsupial" bones in common with those composing the following Order, *viz.* the Monotremata, but are themselves distinguished by a peculiar pouch or duplicature of the abdominal integument, within which in the female are inclosed the teats, and which serves for the protection of the immature young, termed the "marsupium" (whence they have been termed Didelphia); and by the angle of the lower jaw more or less inflected. They are

the E. Ordinaria (*e.g.* Dasypus); and the E. Monotremata (*e.g.* Echidna). All modern Zoologists are agreed that the Monotremata form a distinct Order; consequently the term Edentata, as connoting less than it did in the well-known classification of Cuvier, should be abolished. Again, the term *Bruta* was used by Linnæus to include the Proboscidean Elephant and the Zoophagous Trichæcidæ, and is therefore quite inapplicable here. The term here used is derived from the peculiarity of the teeth of those genera herein included that possess them, *viz.*, that they are *devoid of enamel.*

* Monophyodont.

divided into Seven *Families.*

1. The *Phascolomydæ* (Wombat) present, in the arrangement of the teeth, a considerable resemblance to the Rodentia. 2. The *Macropidæ* are at once distinguished by their exceedingly long and powerful hind legs with elongated feet, resting with their whole sole upon the ground; and forelegs very short. 3. The *Phalangistidæ* have all a large thumb, so separated from the other digits that it seems to be directed backward, as in birds; it has no nail, and the two following fingers are joined by the skin as far as the last phalanx; from this circumstance they have derived the family name. The three preceding families feed chiefly on plants; the next four on flesh or insects. 4. In the *Peramelidæ* the form of the molars would seem to agree with those of the order Insectivora: in structure of hind legs they approach the Macropidæ. 5. The *Didelphidæ* are remarkable as alone of all the Marsupials possessing eight incisors in the lower jaw. 6. The *Myrmecobiidæ* are distinguished from all other Marsupials by the great number of teeth, *viz.* fifty-two. 7. The family of the *Dasyuridæ* includes the largest of the rapacious Marsupials.

XV. The Order MONOTREMATA (μονος, single; τρημα, orifice) is so called in reference to the single excretory and generative outlet found in the three species comprised in it, which however is not peculiar to them among Mammalia. The members of this Order show most distinctly, in all their characters, a relationship to the Oviparous Vertebrata, and have been termed Ornithodelphia.

A TABLE

OF THE

ORDERS, SUB-ORDERS, GROUPS, AND FAMILIES, WITH EXAMPLES

OF THE

CLASS MAMMALIA (μάμμα, a teat).

Orders i. to xiii., inclusive....	M. Monodelphia	s. Placentalia.
Order XIV.	Didelphia	s. Implacentalia.
Order XV	Ornithodelphia	
Orders i. to vi. and xiii. to xv.	M. Unguiculata.	
Orders vii. to x.	Ungulata.	
Orders xi. and xii.	Mutilata.	
Most Mammalia are	Diphyodont	
Orders xi., xiii. and xv. are ..	Monophyodont.	

MAMMALIA PLACENTALIA.

ORDER I.—BIMANA, (*bini*, a pair; *manus*, a hand.)

Sole representative, the genus,	Homo	Man

ORDER II.—QUADRUMANA, (*quatuor*, four; *m*—)

Sub-order 1. *SIMIÆ* (*Simia*, ape.)

Group 1. CATARRHINA (κατὰ, below; ῥις, nose). or SIMIIDÆ (Old World Monkeys).

Anthropomorphous (tail-less) Apes	Troglodytes niger	Chimpanzee.
	Tr. Gorilla	Gorilla.
	Simia	Ourang.
	Hylobates	Gibbon.
	Semnopithecus	Douc.
	Cercopithecus	Monkey.
	Macacus	Macaque.
	Cynocephalus	Baboon.
	Papio	Drill.

„ 2. PLATYRRHINA (πλατύς, wide; ῥ—)

(New World or American M.)	Mycetes	Stentor or Howling M.
	Ateles	Spider Monkey.
	Cebus	Capuchin.
	Callithrix	Sagouin.
	Hapale Jacchus	Marmoset.

Sub-order 2. *LEMURIDÆ*,

Synonymous with STREPSIRRHINA (στρεπτός, twisted; ῥ—)

Lemur	
Lichanotus	Indris.
Cheiromys	Aye aye.
Stenops	Loris.
Perodicticus	Potto.

ORDER III.—INSECTIVORA (*insecta*, insect; *voro*, to eat).

Families,	Galeopithecidæ	Galeopithecus	Flying-Lemur.
	Erinaceidæ	Erinaceus	Hedgehog.
		Centetes	Tenrec.
		Gymnura	Gymnure.
	Soricidæ	Sorex	Shrew.
	Talpidæ	Talpa	Mole.

ORDER IV.—CHEIROPTERA (χεἰρ, hand; πτερόν, wing).

Families Insect diet	Vespertilionidæ	Vespertilio	Bat.
	Rhinolophidæ	Rhinolophus	
Vegetable diet	Phyllostomidæ	Desmodus	Vampire.
	Pteropidæ	Pteropus	Roussette.

ORDER V. RODENTIA (*rodo*, to gnaw).

Sub-order 1. *NON-CLAVICULATA* (*non*, neg.; *clavicula*, a clavicle).

Families	Leporidæ	Lepus / Timidus	Hare
	(except Claviculate	Lagomys	Pika).
	Cavidæ	Hydrochærus	Capybara
		Dasyprocta	Agoutis.
		Cavia	Guinea Pig.
	Hystricidæ	Hystrix	Porcupine.

Sub-order 2. *CLAVICULATA* (*c*—).

Families,	Chinchillidæ	Eriomys	Chinchilla.
	Castoridæ	Castor	Beaver.
	Muridæ	Mus	Rat.
		Arvicola	Vole
		Dipus	Jerboa.
	Myoxidæ	Myoxus.	Dormouse.
	Sciuridæ	Sciurus	Squirrel.
		Pteromys	Flying Squirrel.
		Arctomys	Marmot.

ORDER VI.—SECTORIALIA (*dens sectorius*, or *scissor* tooth).

Sub-order 1. *DIGITIGRADA* (*digitus*, a finger; *gradior*, to step).

Families,	Felidæ (typical)	Leo	Lion.
	Canidæ	Canis	Dog.
	Hyænidæ	Hyæna	
	Viverridæ	Viverra	Civet.
		Herpestes	Ichneumon.
		Genetta	Genetts.

Sub-order 2. *SEMIPLANTIGRADA* (*semis*, half; *planta*, sole; *g*—).

Family,	Mustelidæ	M. Vulgaris	Weasel.
		M. Martes	Marten.
		M. Putorius	Polecat.
		Lutra	Otter.

Sub-order 3. *PLANTIGRADA* (*p*—; *g*—).

Families,	Ursidæ	U. Arctos	Brown bear.
		Procyon	Racoon.
		Nasua	Coati Mundi.
	Melidæ	M. Taxus	Badger.
		Gulo luscus	Glutton, or Fiæl Frass.
	Cercoleptidæ	Cercoleptes	Kinkajou

Sub-order 4. *PINNIGRADA* (*pinna,* fin; *g*—).

Families,	Phocidæ	P. Vitulina	Seal.
		P. Otaria	Eared Seal.
	Trichæchidæ	Trichæcus	Walrus or Morse

ORDER VII.—PROBOSCIDIA (προβοσκίς, trunk).

Family,	Elephantidæ	Elephas	Elephant.

ORDER VIII.—PERISSODACTYLA (περισσος, odd; δακτυλος, digit).

Sub-order 1. *SOLIDUNGULA* (*solidus,* whole; *ungula,* hoof).

Family,	Equidæ	E. Caballus	Horse.
		E. Asinus	Ass.

Sub-order 2. *MULTUNGULA* (*multus,* many; *u*—).

Families,	Rhinoceridæ	Rhinoceros	
	Tapiridæ	Tapirus	Tapir.

ORDER IX.—HYRACOIDEA.

Family,	Hyracidæ	Hyrax	Daman.

ORDER X.—ARTIODACTYLA (ἀρτιος, even; δ—).

Sub-order 1. *OMNIVORA* (*omnis,* everything; *v*—).

Families,	Hippopotamidæ	Hippopotamus	
	Suidæ	Sus	Hog.
		Babyrussa	
		Phascochæres	Wart Hog.
		Dycoteles	Peccari.

Sub-order 2. *RUMINANTIA* (*rumen,* paunch).

Group 1. CARENTICORNUA (*careo,* to be without; *cornua,* horns).

Families,	Camelidæ	Camelus	Camel.
	Moschidæ	Moschus	Musk Deer.

Group 2. SOLIDICORNUA (*solidus,* solid; *c*—).

Families,

Cervidæ	Flattened antlers	Platyceros Dama	Fallow Deer.
		C. Alces	Elk.
		Rangifer Tarandus	Reindeer.
	Round Antlers	C. Elaphus	Red Deer.
		C. Capreolus	Roe.
Camelopardidæ		Camelopardalis Giraffa	Giraffe.

Group 3. CAVICORNUA (*cavus*, hollow; *c*—).

Family and syn., Bovidæ

Antelopes	Gazella Dorcas	Gazelle.
	Bos-elaphus Oreas	Eland.
	Antilocapra	Prong-buck.
	Tetraceros	Chicarra.
	Rupricapra tragus	Chamois.
	Cato Blepas	Gnu.
Goats and sheep	Capra	Goat.
	C. Ibex	Ibex.
	Ammo-tragus Trag-elaphus	Aoudad.
	Ovis	Sheep.
True bovine	Bos	Ox.
	Bonasus	Bison.
	Ovi-bos	Musk ox.

ORDER XI.—CETE κῆτος, a whale).

Families, Balænidæ	Balæna	Whale.
	Balæno-ptera boops	Fin - backed whale or Rorqual.
Physeteridæ	Physeter	Cachalot.
Delphinidæ	Phocæna	Porpoise.
	Delphinus	Dolphin.
	Monodon	Narwhal.
	Hyperoodon	Bottle-head.

ORDER XII.—SIRENIA (σειρήν, a mermaid).

Families, Rhytinidæ (extinct since Dodo.)	Rhytina	Stellerine.
Manatidæ	Manatus	Manatee.
	Halicore	Dugong.

ORDER XIII.—IN-ENAMELLATA (absence of enamel).

Insect-eating	*Families*, Edentula Syn. Myrmecophagidæ	Myrmecophaga	Ant-eater.
		Manis	Pangolin.
	Dasypodidæ	Dasypus	Armadillo
		Chlamyphorus	
		Orycteropus	
Leaf-eating	Bradypodidæ	Bradypus	Sloth.
		B. Tridactylus	Ai.
		B. Torquatus	

[OVER.

MAMMALIA IMPLACENTALIA.

ORDER XIV.—MARSUPIALIA (*marsupium*, a pouch.)

S.
DIDELPHIA

Families,	Phascolomydæ	Phascolomys	Wombat.
	Macropidæ	Macropus	Kangaroo.
		Hysiprimnus	Potoroo.
	Phalangistidæ	Phalangista	Phalanger.
		Petaurus	
		Phascolarctos	Koala.
	Peramelidæ	Perameles	Bandicoot.
		Chæropus	
	Didelphidæ	Didelphys	Opossum.
		Cheironectes	Yapach.
	Myrmecobiidæ	Myrmecobius	Banded Ant-eater.
	Dasyuridæ	Dasyurus	
		Thylacinus	
		Phascogale	

ORDER XV.—MONOTREMATA (μονός, single; τρημα, hole).

S.
ORNITHODELPHIA

Genera	Ornithorhyncus	Duck-billed Platypus.
	Echidna	Spiny Ant-eater.

OSTEOLOGY—General.

I.—*Skull.* The number of separate cranial bones is in most Mammalia less than in Reptilia and Pisces. The occipital condyles are two in number, as in Amphibia, from which, however, they differ in development: the Mammalian *condyles* being *formed by the exoccipitals, in conjunction with the well ossified basioccipital* and not from the exoccipitals alone (Amphibia). The *foramen magnum* is usually situated at the back part of the skull, and generally in a position more or less perpendicular (cf. i. and ii, 1).* Near to, or immediately above it, there occasionally occur persistent fontanelles (cf. vi, 4). The Paroccipital (= 'jugular process' in Man) frequently exceeds the 'Mastoid process' in size. The Sphenoid coalesces with the occipital at an early period.—The *Parietals* are usually small and insignificant, flat, and frequently united together, obliterating the sagittal suture (cf. v. vi. viii, 1. x, 2).—An *Interparietal* bone is sometimes met with (cf. v. ix. xiv).—The *Frontal* is generally but slightly arched, and consists originally of two lateral portions which not unfrequently remain distinct: sometimes a single frontal bone is found (cf. i. ii, 1. iv. vii. viii, 2).—The *sutures* of the bones of the skull generally remain visible throughout life.—The *Temporal* bone consists in the fœtus of four pieces; the squamous, the tympanic, the petrous, and the mastoid: of these the *squamous* portion is for the most part low and compressed; *with it each ramus of the lower jaw directly articu-*

* These figures apply to the Orders and Sub-orders, as numbered in the following section.

lates; and it *sometimes forms part of the wall of the cranial cavity:* this last function of the squamosal is peculiarly Mammalian, but by no means constant in all members of the class. The tympanic portion is attached to the petrous either by suture or ligament, and is of various size and shape (cf. v. vi. xi). The mastoid process is generally very slightly developed.—The Styloid process frequently exists as a separate ossicle.—The *Facial* bones are immovably connected with each other (cf. Aves).—The *Malar* bone is seldom wanting, but varies in size and shape (cf. vi. xi. xiii); its frontal processes seldom reach the frontal bone (cf. viii, 1; x, 2) and very rarely (cf. i. ii, 1) is there an inner plate developed, circumscribing the orbit and zygomatic groove. The *Lachrymals* are very rarely wanting, but vary in size (cf. vi, 4; viii, 1; x, 2; xv), being usually more developed than in Bimana, and contributing more to form the inner wall of the orbit, where they seem to occupy the place of the ethmoid. The *Nasal* bones are generally double, and very long (cf. ii, 1; viii, 1; x, 2).—The *Intermaxillaries,* which in Bimana are distinct only in the earliest fœtal periods (till the fourth month) occur in all other Mammalia, and generally support incisor teeth (cf. x, 2. &c.): they frequently coalesce in old individuals at the median line, and with the superior maxillary bones.—The *Superior Maxillaries* are more elongated than in Man, and have a broader nasal process. The *Palate* bones have, in most Mammalia, a large horizontal piece, by which the posterior part of the hard palate is formed (cf. iv.)—Each of the two *Rami of the lower jaw,* though developed from several centres of ossification, consists in the adult of but one single bone, which has generally an ascending process: and which articulates directly with the squamosal element of the skull, and not with the representative of the quadrate bone of the lower Vertebrata, which in the Mammalia is appropriated as malleus to the service of the organs of hearing: the articu-

lating condyle is of diverse form (cf. v. vi. x, 2), but usually has a convex or flat facet. The rami are united anteriorly sometimes by symphysis, generally by ligamentous fibres: the lower border of the symphysis is in Bimana alone curved forwards and upwards (cf. ii, 1).—The *Sphenoid,* as above said, coalesces early with the occipital; the size of the wings varies; the pterygoid processes sometimes remain separate throughout life (cf. xv.); sometimes coalesce with the surface of the Palatal bones. The separation of the body of the Sphenoid into two parts (*vide* Introduction) as seen in the Human embryo persists in most Mammals for the whole of life. The *Ethmoid* is more largely developed in this than in the other classes of Vertebrata, and here alone deserves the name which it has received in human anatomy, from its perforated upper surface, or cribriform plate: in very few Mammalia (cf. i. ii.) is the smooth lateral plate forming the inner wall of the orbit (lamina papyracea) present.—The *Inferior Turbinate bones* seem to be present in all Mammalia.—The *internal surface of the cranium* presents a cavity which, as in Aves, is entirely occupied by the brain, and is thus the cast of its surface; in Man it may be divided into a posterior, middle, and anterior region, which do not lie in the same plane, the posterior (cerebellar) being the lowest: in other Mammalia these regions are less obviously distinct from each other, and lie more at the same height. The depressions for the lodgement of the cerebrum and cerebellum are sometimes separated by a *bony* tentorium, prolonged inwards from the posterior part of the parietal bones (cf. vi. viii, 1. xi.) and the superoccipital.

II.—The *Vertebral Column.* The *articular surfaces* at each end of the well ossified centrum of a Mammalian vertebra are generally *flat:* they are however sometimes cup-shaped behind and spheroidal in front* (cf. x, 2.). This was also

* Opisthocœlian centrum.

a character of many extinct reptiles: but, as distinctive of Mammalia, note that these articular surfaces are in this class *developed as separate, discoidal, epiphysial plates,* which continue for a longer or shorter period of life, and then coalesce with the body. Each vertebra is developed from five centres of ossification: two for the epiphyses, two for the neural arch, and one for the body: but the *sutures between the elements of the neural arch and the centrum are early obliterated,* generally before the epiphyses coalesce with the centrum. The centra are articulated by concentric ligaments, composed of fibrous tissue and cartilage, forming the so-called "*intervertebral cartilages.*" The vertebral column is generally (? xi.) divided into the same regions as in Man, *viz.*, cervical, dorsal, lumbar, sacral, and caudal. It exhibits great constancy in the number of vertebræ in the *Cervical region*: there are generally seven (cf. xii, xiii.): the great variations in the length of the neck being solely dependent upon that of the centrum of each vertebra (compare centrum of cervical V. of Giraffe with that of Balæna). The first (atlas) and second (axis) cervical vertebræ present a curious anomaly, in that the centrum of the atlas has in the adult coalesced with that of the axis. The atlas has constantly in Mammalia two articular cavities for the reception of the two condyles of the skull. The cervicals are generally all movable on each other (cf. xi.), and have their transverse processes perforated for the vertebral artery. The number of *Dorsal vertebræ* varies, but there are seldom fewer than twelve (cf. iv.) or more than fifteen (cf. vii. xiii.): the spinous processes are seldom wanting (cf. iv.), and are generally long and thin, and slope towards one in the latter half of their series which is vertical, rises from the thence named "anticlinal" vertebra, and indicates the centre of motion of the trunk. To these spines is attached the ligamentum nuchæ, and with it they form what is termed the "withers." The ligamentum nuchæ has its anterior attachment on the spine of the second

cervical, and often on the crest of the occipital bone also: it is represented in Bimana by a condensed band of the fascia nuchalis. The *Ribs* correspond in number with the dorsal vertebræ; and each rib is usually connected, by its head with an articular cavity, formed by the bodies (cf. xi.) of two vertebræ, and in addition (cf. xv.), backwards, by a tubercle, with the transverse process of the posterior of those two vertebræ. The continuations of the ribs by which they are united to the sternum remain in most Mammalia cartilaginous (cf. xi. xiii. xv.) during the whole of life (= costal cartilages). The anterior ribs usually extend as far as the sternum*; in which respect Mammalia differ from Aves.—The *Sternum* is usually narrow, and consists of a simple longitudinal series of bones, instead of having the second, third, fourth and fifth segments fused, as in the adult Man. There is generally no episternum. The manubrium sterni presents considerable differences, but generally receives the clavicles when present, and the two first ribs (cf. iii. iv. xv.). The ensiform process varies both in length and shape (cf. v. xiii.). The *Lumbar* vertebræ are generally the larger, and vary in number from three to seven. A well défined *Sacrum* is generally present (cf. xi. xii.): as a rule it is very narrow (cf. i. ii.) and is composed of from two to five vertebræ, generally united (cf. xv.) together, and not anchylosed inferiorly to the pelvis (cf. xiii.). The sacrum in Bimana retreats backwards, and makes an angle with the lumbar vertebræ; in the rest of the Mammalia, on the contrary, it lies nearly in the same plane with the lumbar vertebræ, and is hence said to be "straight." *Caudal* vertebræ are generally present (cf. i. ii.): the anterior ones are similar to those in other series, most of the usual processes being present,† and generally inferior processes also, [= hæmapophyses, or "*Chevron*" bones] articulated with the

* Exc. Bradypus tridactylus. † The pleurapophyses are absent altogether.

centrum, leaving a canal for the blood-vessels of the tail: but towards the end of the tail they dwindle gradually in size, lose their processes, cease to have an arch, and assume the form of a double cone, resembling the phalanges of fingers. Anchylosis is an exception (cf. xiii.) in this region.

III.—The *Scapular Arch and Appendages.* The anterior pair of limbs is never absent in Mammalia. As is the case with the vertebral bodies of Mammalia so is it with the limb bones; almost all of which have the articular surfaces, in the growing state, supported on distinct plates, called epiphyses, which usually coalesce with the rest of the bone at maturity. The *Scapula* is generally present as an expanded plate of bone, but is of varied width (cf. iii. xi.), length (cf. iii. iv.), and size (cf. x, 2.): the pre-scapular ("supra-spinous") or anterior fossa is almost invariably larger than the post-scapular (infraspinous) fossa. The *Coracoid,* though developed from an independent osseous centre, generally coalesces with the scapula, of which it appears as a small process (cf. xv.). The *Clavicle* (= the os furculare of Aves), when present varies much in shape and size (cf. vii. ix. x. xi. xii.); it is generally united to the acromion (cf. xiii.) by ligament, and is usually single (cf. xv.) on either side. The whole of the scapular arch is specially modified in the Monotremata (cf. xv.). The *Humerus* and bones of the fore-arm (antibrachial) and hand are specially modified according as the animal lives in air or water, or burrows beneath the surface of the earth. There is no power of rotation of the fore limb in any hoofed quadruped. There are usually two bones in the fore-arm, the radius and ulna, which admit of various degrees of rotation. The *Humerus* is generally straight (cf. vi.); in swimming and fossorial animals it is very short (cf. iii. xi. xv.), otherwise it may be described as characterised in the normal Mammalia by having a head, tuberosities, deltoid crest, twisted shaft, epicondyloid processes, and intermediate trochlear articular surface for

synovial articulation with the proximal ends of radius and ulna. The olecranal fossa is not always complete (cf. v. vi.), nor is the internal condyle always *im*perforate (cf. v. vi. xiv.). The *Ulna* is almost always longer than the radius (cf. iv. xiii, 1.), and generally provided with an olecranon (cf. xi.) of variable size (cf. xiii.): in those herbivorous quadrupeds which are organised for rapid motion, both bones lie behind each other, are immovably united, and more or less anchylosed. The *Carpus* consists usually of eight small bones, ranged in a double row, varying in shape (cf. iii. xi.) and number, but with this constant character, that the os unciforme always supports the two (when present, cf. Bradypus) outer metacarpals. The *Metacarpus* consists for the most part of five separate (cf. xiii.) elongated bones: between the metacarpals and the first row of phalanges are situated, very generally, certain sesamoid bones (cf. viii, 1.). The number of *Phalanges* in a finger rarely exceeds three (cf. xi.), and in the thumb there are usually two. The number of fingers varies from one to five: of these five the third or middle finger is the most constant, and commonly also the longest (cf. viii, 1.): the first or inner digit (the thumb) is the first to disappear; if there are two absent, the fifth or outer digit, (the little finger) is the second to disappear: after these the second, or index finger; and then the fourth, or ring finger.

IV.—The *Pelvic Arch and Appendages*. The appendages of the Pelvic Arch may be wholly wanting (cf. xii.) or rudimentary. The *Pelvis* in other Mammalia is never so broad as in Bimana, and its lateral walls are always smaller, flatter, and longer. The *Ilium* seldom articulates with as many sacral vertebræ as in Aves (cf. xiii.). The *Ischia* and *Pubes* are generally well developed. The pubic articulation (cf. iii. iv.) is frequently very deep; it is formed also by the ischia, and is very often converted into bone. The *Acetabulum* is almost always complete; and has frequently a depression for the

insertion of the ligamentum teres; it is generally imperforate (cf. xv.). From the anterior or upper border of the pubic bones there frequently arises a pointed spine-shaped eminence (eminentia ilio-pectinea), which is the first indication of the Marsupial bone (cf. iv. xiv. xv.). The *Femur* retains more of the human form in the different orders (cf. iv. vi.) than does the humerus: the external trochanter is often very large, and extends beyond the head of the bone: the internal trochanter is occasionally wanting: a "third" trochanter, a strong process more or less in the middle line, is found in a number of animals (cf. ix.). Whilst in Bimana the axis of the femur deviates little from that of the vertebral column, in all other Orders (including the highest Catarrhina, *viz.*, the tail-less Apes), the femora are bent more forwards, and form an obtuse angle with the pelvis. A *Patella* is very generally met with. In the leg the *Tibia* is always the principal bone, and main support of the femur. The *Fibula* presents many varieties (cf. xv.), and is often very rudimentary (cf. iii, iv. viii, 1.). The average number of the *Tarsal* bones is seven, and they are generally separate. The *os calcis* has commonly a long process for the attachment of the tendon Achilles (cf. iv.). The *Metatarsals* vary in number; those of the principal toes in the leaping animals are long, and partly united together (cf. v.). The same remarks apply to the toes as made above on the fingers. Among Quadrupeds the Elephant furnishes an example of the pentadactyle foot; the Hippopotamus of a tetradactyle foot, having digit i. (inner) withdrawn; the Rhinoceros of a tridactyle foot, having digits i. and v. (outer) withdrawn; the Ox of a didactyle foot, with digits i. and v., and ii. (index) withdrawn; and, lastly, the Horse, of a monodactyle foot, having digits i. and v., and ii. and iv. withdrawn.

OSTEOLOGY.—Special.

I.—BIMANA.

The *Skull.* The united area of the cranial bones exceeds that of the facial bones very considerably. The width between the outside edge of each orbit does not exceed the extreme width of the cranium between the parietal eminences. An inner plate is developed from the *Malar* bone, which is united with the great ala of the sphenoid, and forms with it a wall by which the cavity of the orbit is so separated from the temporal fossa, that a fissure alone is left. The *Nasal* aperture is frequently half as large as the orbit; it is situated between the lower borders of the orbit; the nasal bones are arched transversely. The ethmoid has a crista galli. The perihery or alveolar border of the *Upper Jaw* forms a continuous semi-elliptic curve, uninterrupted by the projection of any one excessively developed alveolus. The bony *Palate* is deep and broad, though short; is arched both lengthwise and transversely; and is formed by the palatines, maxillaries, and small confluent pre-maxillaries, supporting the incisor teeth. The plane of the alveolar border of the upper jaw, passes through the floor of the cranial cavity; the whole cranium being much expanded backwards and downwards; and the *Foramen Magnum,* which is placed near the centre of the base of the skull, approaching the horizontal direction. The *Mandible* has a well-defined and not rounded angle: the rami become united in the median line at an early period before or after birth: the *symphysis menti* forms with the base of the rami a sharp angle, and has its lower border frequently slightly turned up anteriorly. The body of the *Hyoid* bone (basi-hyal), is compressed antero-posteriorly, and curved and extended transversely; but not expanded or excavated behind. The lesser cornua of the hyoid (cerato-hyals) are represented by mere tubercles. The Stylo-hyal is anchylosed with the 'Temporal' bone, forming the 'styloid process.' The *Jugular* processes are very small, but the *Mastoids* are well developed. The *Intermaxillaries* are not distinct on the facial surface.

The *Vertebral Column.* The number of vertebræ in each series is generally constant, viz: *Cervical,* seven; *Dorsal,* twelve; and *Lumbar,* five. The first and three posterior *Ribs* have a single articular surface on the head; the rest have it divided into two facets: the *tubercular* articular surface is wanting in the last two pairs. Occasionally a pair of tubercles on the anterior border of the manubrium indicate rudiments of an *episternum.* A characteristic distinction of the human *Lumbar* vertebræ is the backward production of the posterior zygapophyses occasioning the deep posterior emargination of the neural arch. The *Sacrum* is broad and slightly concave anteriorly, both lengthwise and transversely. The *Caudal* series is reduced to four or five aborted vertebræ.

The *Scapular arch and appendages.* The *Clavicles* are always present and complete, though slender in proportion to the length; and the curves are always fairly marked. The *Scapulæ* are very broad in proportion to their length: the direction of the spine and acromion is distinctly transverse. In the *Humerus* the condyloid processes are not very largely developed; the intercondyloid perforation is occasionally seen. Both *Radius* and *Ulna* are slender and short relatively to the humerus. The opposable thumb is restricted to the upper pair of limbs. The terminal portions of the *ungual phalanges* are long and broad, in order to support the surface specially developed for a refined touch.

The *Pelvic arch and appendages.* The *Pelvis* is short, broad, and wide, keeping the thighs well apart. The sacro-iliac symphysis is subquadrate; the symphysis pubis is short. In Man alone are the boundaries of the brim or inlet of the pelvis (*i.e.,* the cotylo-sacral tract of the ilium, and the body of the pelvis), on one plane. The *Ilium* is broader than it is long; concave internally, and concave posteriorly,* especially in the vertical direction. The whole of its curved border is much developed, especially the anterior inferior spine (for the straight tendon of 'rectus femoris'), the top of the crest, or external labrum, and the large backward projection formed by the posterior angle (for the 'glutæus maximus'), each testifying to the important share taken by the muscles thence arising in maintaining the erect position. The *Pubis* is short and thick; an oblique groove is present beneath the pubic boundary of the obturator foramen. Anchylosis of the Pubes rarely takes place in Man.

* On account of the thickness of the 'crest.'

The *acetabulum* has a decided tendency to face outwards. In proportion to the trunk the *Pelvic Limbs* are longer than in any other animal; they even exceed those of the Kangaroo (Macropus), and are peculiar for the superior length of the femur, and for the capability of this bone to be brought, when the leg is extended, into the same line with the tibia. The neck of the *Femur* (cervix femoris) is long, and forms an open angle with the shaft: as characteristic, note the double obliquity of "neck" and "shaft," whereby the femora are brought to converge to the knee joints. The great trochanter does not rise so high as the head of the bone. The linea aspera is bent forward and developed like a buttress. The distal end is considerably expanded, and the two condyles, especially the inner one, much produced backwards. The *Tibia* is the second longest bone of the skeleton, and is of tolerably equable diameter, though expanded at its proximal end to form the knee joint. The slender *Fibula* articulates with the external aspect of the Tibia below the knee. The outer or *Fibular malleolus* descends lower and more vertically than the inner or tibial malleolus, restraining to a great extent all lateral inflections of the foot upon the leg. The *Foot* is short in proportion to the leg, and is so articulated that the sole is directed downwards. The tarsal and metatarsal bones are co-adjusted so as to form arches, both lengthwise and across, and receive the superincumbent weight from the tibia on the summit of a bony vault, which has the advantage of a certain elasticity combined with adequate strength. The *Calcaneum* developes posteriorly a considerable tuberosity. All the five *Toes* have the same direction, forwards; they are short, but with the innermost longer, and much larger than the rest, forming a "hallux," or great toe, which is placed on the same line with, and cannot be opposed to the other toes; on the hallux the whole force of the "flexor longus hallucis" is exclusively concentrated.

II.—QUADRUMANA.

The *Skull.* The form of the cranium has no approximation to the oval type of Bimana. The *facial area* is unusually large relatively to the cranial (cf. i.); and there is but slight, if any, expansion of the cranium backwards or downwards. The *Foramen Magnum* rarely assumes anything approaching to a horizontal position, and is always placed towards the posterior part of the base of the skull. The *Mastoids* are generally represented only by small tubercles. The *Paroccipital* process is rudimentary. The *Inter-*

maxillaries are distinct on the facial surface. The *Orbits* are completely circumscribed by an osseous ring; but the temporal and orbital fossa are seldom entirely separated, except in the Catarrhina. The *Glenoid cavity* is usually less deep than in Bimana, and is bounded posteriorly by a well-marked post-glenoid ridge (exc. Cheiromys). The *Alveolar* border of the upper jaw never forms a regular curve; and even when it approaches that shape, has some of the alveoli protruding beyond the rest. The *Rami*, of the lower jaw, are rounded off at each end, both at the symphysis and at the "angle." The *Basi-hyal* is generally expanded and excavated posteriorly; and the *Cerato-hyals* developed into processes, being very rarely represented by mere tubercles (*e.g.* in Gorilla). The *Nasals* are generally flat. In the *Ethmoid* the crista galli is very rudimentary (exc. Cercopithecus). The *Clinoid* processes of the sella are generally small or rudimentary, except in the Catarrhina. Very commonly a division of the *Lateral Cerebral venous sinus* excavates the base of the petrosal, to terminate at the post-glenoid fossa. (? Catarrhina.)

1. *Catarrhina.* In all Catarrhina the bony septum between the orbital and temporal fossa is complete. The *nasals* are flat, small, and generally coalesced. In young Apes the *foramen magnum* sometimes assumes a horizontal position. The rami are generally coalesced early at the symphysis. There are seldom any "post-glenoid" outlets of the lateral sinuses (exc. Hylobates.) *The tentorium is never ossified.* The preclinoid and postclinoid processes are well developed.

2. *Platyrrhina.* The frontal suture is obliterated in all, and the single bone thence resulting is triangular, with the apex extending back between the parietals, in some capuchins (cebus) as far as the superoccipital, thus repeating a Piscine collocation of supra-cranial bones. In most of this group (exc. Callithrix) the plate which divides the *orbital* from the *temporal fossa*, exhibits a small unossified vacuity. The *lachrymal foramen* is within the orbit (cf. ii. 3), and the *orbital walls* project considerably into the cranial cavity. The *mandibular rami* of *Mycetes* are especially to be noted on account of the extraordinary depth of their angular and ascending portions; this development relating to the protection and support of the still more extraordinarily developed hyoidean and laryngeal apparatus. The *Hyoid* arch is reduced to the basi- and thyro-hyals only; but of these, the former is enormously developed and expanded into a capacious sac, with thin walls, and a posterior opening admitting a laryngeal pouch.—In other Platyrrhina the cerato-hyals are present, and the basi-hyal is slightly excavated, forming in Hapale only a convex plate. The lateral sinuses have "post-glenoid" outlets. *Ateles* furnishes an example of *ossification* continued into one half of the *tentorium.*

3. *Lemuridæ* (or Strepsirrhina). In most Lemuridæ the cranial sutures are "harmoniæ*"; and the facial part of the skull is produced. The *orbits* are large and expanded; *orbital and temporal fossæ communicate freely*; the *lachrymal foramen* is on the face. The coronoid process of the mandible is well developed. In Cheiromys the 'symphysis' menti is ligamentous. The anterior *Cornua of the hyoid* are generally longer than the posterior, and include cerato- and epi-hyals, supporting a cartilaginous stylo-hyal. The *glenoid cavity* is generally defended by a posterior ridge (exc. in Cheiromys, in which the absence of this ridge admits of the free movement of the mandible backwards and forwards requisite for the Rodent action of the great scalpriform incisors). The *lateral cerebral venous sinuses* have a division in the base of the petrosal.

The *Vertebral Column.*—All have seven cervical vertebræ; and the majority have 19 vertebræ in the dorso-lumbar series: throughout which interlocking joints are commonly found, except in the highest Apes. In all, except in these same "anthropo-morphous" Apes the sternal bones are slender.

Catarrhina. In *Anthropomorphous Apes*,—the pleurapophysial part of the vertebræ in the cervical region projects distinctly below the diapophysial part, without however acquiring that antero-posterior breadth which gives it the lamelliform character in the inferior Apes;—the *sternum* consists of the manubrium and generally of two or more broad and flat bones, coalesced to form the 'body;'—the vertebræ *never have interlocking joints*:—the *sacrum* is sometimes broad and slightly concave:—lastly, the *caudal* vertebræ are frequently reduced to five, anchylosed and aborted, but longer and narrower than in Bimana.

In most of the other Catarrhina, the centrum of the *axis* is much produced backwards, underlapping that of the third vertebra. The posterior *dorsals* and antérior *lumbar* vertebræ frequently have the anapophyses developed as separate processes, and the metapophyses provided with a facet for the accessory articular surface of the posterior zygapophysis of the preceding vertebra: being thus provided with an additional interlocking apparatus.

All *Platyrrhina* have a long *tail*, which is in most prehensile, and composed of about thirty vertebræ (ex. Callithrix, 18.) The *inter-cervical articulations* frequently tend to the ball-and-socket type. In Hapale (Marmoset) the centrum of the vertebra succeeding the Atlas is produced posteriorly into a convex prominence which fits into a concavity on the forepart of the centrum behind. In Ateles (Spider Monkey) the third to the sixth cervical vertebræ inclusive show an anterior concavity and a posterior convexity on the articular ends of the centrums in the transverse direction, an anterior convexity and posterior concavity in the vertical direction, producing an interlocking joint, combining strength with freedom of motion, and analogous to that in the neck of Birds.

* Of bastard or false (notha) sutures (*i. e.* sutures formed by rough surfaces), those that are formed by the apposition of contiguous surfaces are termed 'suturæ nothæ appositæ,' or in one word *harmoniæ*.

In the *Lemuridæ* the *cervical* vertebræ are generally broad and short, and their neural arch is low and flat, and sometimes fissured behind (Indri). The centra of the *dorsal* vertebræ of the Cheiromys (Aye-Aye) are carinate; the neural spines are commonly all of equal strength. In the true Lemurs eight pair of *ribs* join the sternum, which consists of seven bones and an ensiform cartilage.

The *Scapular Arch and Appendages.*—The anterior pair of limbs aid in support and locomotion. *Clavicles* are always complete. The *Coracoid* process of the scapula is usually large and long. The *Elbow* joint allows of both rotatory and flexile movements of hand and fore-arm. Most Quadrumana have the innermost digit opposable, *i.e.* have a true *pollex*, or thumb.

Catarrhina. The curves of the *clavicles* are usually not well marked: these bones are of excessive length in the "Long-armed" Apes. The *humerus* is seldom perforated even slightly at its distal extremity: the condyloid processes are considerably developed. The peculiar length of arm in the "Long-armed" Apes (*e.g.* Siamang, Hylobates) is chiefly due to the unusual length of the antibrachial bones. All Catarrhina have a true pollex, except Colobus.

Platyrrhina. In Ateles (Spider Monkey) the long and large *coracoid* has an angular tuberosity, which sometimes joins the anterior costa, so as to circumscribe the prescapular notch. The humerus is in this group seldom perforated, either above or between the condyles.

Lemuridæ. In Lichanotus (Indri) the *coracoid* is especially large and strong. The *humerus* is usually perforated above the inner condyle: when bent upon the chest the humerus reaches to the tenth rib:—this length is characteristic in this Sub-order. In Cheiromys the middle *metacarpal* is remarkable for its extension, and sudden contraction in size towards the distal extremity. The fourth digit is always the longest in this Sub-order, except in Cheiromys, in which the phalanges of digit iii. are attenuated to form the hooked probe-like finger.

The *Pelvic Arch and Appendages.* The *Pelvis* is long and narrow. The *Iliac* bones are long, more or less *flat,* slender, and extended (except in the highest Apes) in a continuous line with the sacrum. The *Ischia* are in a line with the ilia. The *Acetabula* have a tendency to face forwards, and towards each other. The *Femur* has usually a short neck, is itself short, and so articulated with the leg bones as to retain habitually a bent position of the knee: the great trochanter usually rises to the height of the head of the femur. The innermost digit of the posterior pair of limbs is always opposable, *i.e.* in a thumb-like condition, as in the hands; hence the name of the Order, Quadru-*mana.*

Catarrhina. The posterior angle or spine of the *ilium* is above the sacral surface, not behind it (as in Man). In all that have dermal callosities, the *ischia* are expanded into rough flattened tuberosities. There is no oblique

groove beneath the *pubic* boundary of the obturator foramen (cf. i.). The linea aspera of the *femur* is little developed, and the outer articular condyle is narrower than the inner one, the reverse being the case in Man. The *articulation* of the bones of the leg with the *tarsal* bones favours the oblique position of the foot, and adapts it for grasping. The *ectocuneiform* has commonly a convex articular surface for the hallux, which articular surface in Man is nearly flat: the difference being significant of the different function of the hallux in the two species: the chief fulcrum of the foot requiring a firm articulation in Man, but in the higher Apes, *e.g.* Gorilla, requiring great extent of motion for the function of this opposable grasping thumb.

Lemuridæ. In the Spectres (Tarsius) the excessive length of the *calcaneum* is remarkable: hence their generic name.

III.—INSECTIVORA.

The *Skull.* The *cranial cavity* is small, and the outer surface is commonly smooth, and devoid of crests. The *Orbital* and *Temporal fossæ* communicate freely (? *Galeopithecus**). The *Malar* bones are generally slender, and are usually either suspended in the zygoma (*e.g. Galeopithecus*), or applied like a splint along the outer and under side of the junction of the zygomatic with the maxillary (*e.g. Erinaceus, Gymnura*). In *Centetes* the Malar is entirely absent, and the Zygomatic arch incomplete. The *Tympanic* is frequently present as a delicate ring. In Talpa the pyriform skull is prolonged by a *prænasal* ossicle.

The *Vertebral Column.* All the *processes* are relatively *small* throughout the vertebral column. The *Sacrum* is narrow. The *Symphysis Pubis* is short or absent (*Talpa, Sorex*).

In *Talpa* the first sternal bone, or *Manubrium*, is of unusual length, being much produced forward, and has its under surface produced downwards, in the shape of a deep keel, for extending the origin of the pectoral muscles.

Bones of the Limbs. All the Insectivora have perfect *Clavicles;* the *Scapula* is generally long; the *Legs* short and unguiculate; the *Feet* plantigrade, generally five-toed, none opposable.

The peculiar development of certain of the *Limb-bones* obtaining *in Talpa* deserve special notice; thus—The *Clavicle* is cubical (an unique form in Vertebrata), is articulated firmly to the anteriorly projecting breast-bone, but attached to the acromion by ligament. The *Scapula* assumes Ornithic proportions, its length being more than six times its extreme breadth, it is trihedral save in the middle, where it is cylindrical. The *Humerus*, as in most fossorial animals, is of great breadth, and provided with singular inequalities of surface for the attachment of muscles; it is a sub-quadrate, lamelliform bone, with a proximal articulation for the clavicle as well as for the scapula.† The *Carpal* series has added to it a large supplementary sickle-shaped bone, extending from the radius to the metacarpal of the pollex.

* The orbit is partly defined behind by long and slender processes of the frontal.
† And, as in *most animals that scratch*, has the inner condyle perforated.

IV.—CHEIROPTERA.

The *Skull.* In most *insect-eating* Bats the *Superoccipital* slopes backwards, and contributes to the crista continued forward by the interparietal and parietal bones. The *Occipital Foramen* is very large in most of the Order. The *Mastoid* is large and distinct, giving attachment to the tympanic. The zygomatic parts of the *Squamosal* and *Malar* are slender. The *Præmaxillaries* are very small: in some (*e.g. Rhinolophus*) they are wanting. The *Orbital* and *Temporal fossæ* communicate freely. The Tympanics are very slightly connected with the skull. In the frugivorous Bats (Pteropus) the Malar is situated as in the Insectivorous Erinaceidæ.

The *Vertebral Column.* The *Spinal Column* gradually diminishes in size, from the cervical to the sacral region. The *neural spines* are generally of very small size in all vertebræ beyond the dentata. The *Sternum* is carinate.

In *Pteropus* the keel of the large manubrium sterni is produced into a process at each angle.

Scapular Arch and Appendages.—The *Scapula* is generally broad. The *Clavicle* arched, long, and strong. The *Humerus* and *Radius* long and slender. The *Ulna* rudimentary or absent. The *Finger-bones* radiate widely from the wrist, the thumb is short, and furnished with a long claw. The *Metacarpals* of the four clawless fingers are excessively elongated; these, together with the bones of the arm, are, in the natural state, united by a delicate leathery membrane.

Pelvic Arch and Appendages. The *Pelvis* is feeble and slender. The narrow subcylindrical *Ilia* coalesce with the sacral vertebræ, and are parallel with the spinal column. The *pubis* is continued in a line with the ilium to the 'symphysis,' which is generally but slightly closed in the male, and remains open in most female bats. The *Hind Limbs* are short. The *Fibula* is absent or rudimentary. The *Heel* has generally appended to it a long and slender styliform bone, which helps to sustain the *Caudo-femoral membrane.*

V.—RODENTIA.

The *Skull.* The confluence of the elements of the epencephalic arch* is late. The *squamosal* maintains its individuality; and frequently has developed from it long compressed lamina, which serve to clamp the tympanic and mastoid, or one or other of them to the side of the cranium. The *malar* is suspended in the middle of the

* 'Occipital bone' of Anthroptomy.

zygomatic arch. Anteriorly to each orbit there is usually present a wide vacuity, termed the *antorbital foramen*, of variable size; in Helamys Capensis (Cape Jerboa) it is larger than the orbit. An *interorbital foramen* is also frequently found; the common outlet of the optic nerves (*e. g. Lepus*) extending forward so as to occasion a small vacuity at the back part of the interorbital septum. The *temporal* and *orbital fossæ* are *blended* together in all Rodentia. The *nasal* and *frontal* bones are frequently large and long, both being especially developed in Hystrix Cristata (Porcupine). *Osseous bullæ* are generally present, formed by the petro-tympanic. In most Rodentia the anterior part of the *vomer* articulates with the median ascending process of the præmaxillary, arching over the wide vacuities which lead from the nasal passages to the *prepalatine aperture*. The *lower jaw* is modified for the lodgement of the pair of long scalpriform incisors, the sockets of which may extend to the middle (Lepus) or even to the hind part (Castor, Hystrix) of the ramus. In all Rodents the condyle is convex transversely and extended longitudinally (? Lepus) in which direction it is chiefly moveable, to give a full action to the gnawing incisors: there is sometimes found (*e.g.* in Capybara and Cavia Cobaya) a process directed backward from the angle of the jaw.

The *Vertebral Column.* The neural spine is usually longest in the second and seventh *cervical* vertebræ: it is obsolete in the intermediate cervicals in many Rodents. In all the agile, flexible bodied Rodents the neural spines incline towards the 11th (? Lepus) dorsal, the spine of which is vertical, and indicates the centre of motion. The thoracic *ribs* consist of bony pleur-,and gristly hæm-apophyses. In some Rodents, the Ensiform process is expanded behind into a thin cartilaginous disc. Throughout the lumbar region both an- and met-apophyses are generally well developed; long hypapophyses are also developed. In most Rodents with long tails hæmapophyses are developed beneath the intervertebral spaces, *e.g.* Dipus (Jerboa).

Limb bones. There are few generalizations deducible from the limb bones ef Rodentia, since the habits of the several species composing this order are so various; some have limbs giving power in running, some in swimming, some in burrowing, some in leaping, some in climbing, and a few show modifications in relation to parachute-like expansions of integument for a kind of flight. The *Clavicles* are frequently represented by *slender ossicles* freely suspended (*e.g.* in Lepus timidus,—Dasyprocta, Capybara,—and Hystrix): when this

is the case, the radius and ulna are generally found in close contact, or actually anchylosed;—the humerus is generally perforated, but only *between* the condyles; and—the tibia and fibula are distinct. On the other hand,—when the *clavicles* are *complete* (*e g*. in Castoridæ, Sciuridæ, Muridæ, &c.) the bones of the fore arm are generally distinct (ex. Pteromys);—the humerus has the inner condyle perforated, and,—the tibia and fibula are usually coalesced. In some Rodents the spine of the *Scapula* is extended into an acromion at some distance beyond the glenoid cavity and there developes a retroverted process: the intermuscular cristæ on the subscapular surface are usually well marked. In Pteromys a strong accessory cartilage projects from the ulnar side of the carpus, which aids in supporting the lateral fold of integument there developed.

As in other burrowing animals, the *lumbar and pelvic regions* of those Rodents that burrow are narrow. In the Guinea-Pig the ossa innominata can glide on the sacro-iliac joints, the symphysial ligament being extensible. In most Rodents the *femur* has a slender neck and lofty trochanter.

VI.—SECTORIALIA.

All the bones of the Skeleton are remarkable for their whiteness and compact structure.

The *Skull.* The upper contour of the Skull is generally rather straight: an *Occipital crest* is always developed; but though the *Temporal ridges* usually meet, they by no means always form a *Sagittal crest* of any size. Most Carnivora have the *Orbit* incomplete behind, and the Orbital and Temporal fossæ continuous. The *Maxillaries* usually contribute to form the anterior border of the orbit. There is generally an *Antorbital foramen;* its size is indicative of the size of the nerve (2nd div. of V.) supplying the well developed whiskers. The *Frontal* seldom, if ever, sends any *process* to join the Malar. The *Malar* generally bifurcates posteriorly, and it *alone* in most cases forms the *post-orbital* process; the squamosal element (zygoma) not extending so far. The *Zygomatic* process is generally thick and large, and forms an expanded arch. The *Mandible* is short and strong; the articulating condyle is much elongated transversely, and locked in a deep cavity of corresponding form in the squamosal, so as to admit of no lateral motion, and almost restricting the movements of the mandible to one plane, for biting and dividing, not pounding the food: the *Coronoid* process is broad and high, to give insertion

to the large temporal muscles (the fossæ from which these rise are large and deep, and augmented by peripheral ridges of bone); there is generally a process directed backwards from the angle of the jaw. *Acoustic bullæ* are commonly found, supported by the paroccipitals, and developed either from the petrosal, or tympanic, or both, but never from the Ali-sphenoid as in Thylacinus.* The *Paroccipital* and *Mastoid* processes are sometimes distinct, sometimes connate, but both tolerably developed. A narrow articular surface upon the *Basi-occipital* is frequently found connecting the two condyles. The *Petrosals* are generally perforated by the ento-carotids, and impressed internally by a pit for the cerebellar 'flocculus.' The *Tentorium* is always ossified, and usually the posterior part of the *Falx* also.† The *Rhin-encephalic* fossæ are generally well defined, and completely divided both inter se by a thick *Crista galli*, and usually from the *Pros-encephalic* compartment also by a low ridge. The *Olfactory chamber* frequently extends above, and in some cases also underlies the Rhin-encephalic fossæ; it always contains large and complicated turbinals.

Digitigrada. In most Digitigrada the *frontal region* is convex transversely, but depressed in the median line: the *sagittal* crest is largely developed: the *paroccipitals* and *mastoids* have coalesced on each side to form a triangular plate, broad and thick, and supporting the back part of the acoustic bullæ. The triangular *occipital* region is remarkable for the depth and boldness of the sculpturing of its outer surface, especially in Felidæ, in which the carnivorous character reaches its maximum. The *pterygoids* are perforated by the ecto-carotids only, in the Viverridæ alone, in which group also are to be found instances of the *frontal* developing orbital processes, which meeting the malar, circumscribe the rim of the orbit (*e.g.* Ichneumon Mangusta).

Semi-plantigrada. The sagittal crest is small. There is a considerable post-orbital constriction. In most Mustelidæ the rhin-encephalic fossa is less distinctly defined from the cranial cavity than in the Plantigrada: but in the Lutra the cranial cavity is remarkable for its great posterior expansion, and its extreme contraction between the rhin- and pros-encephalic divisions.

Plantigrada. Both *Paroccipitals* and *Mastoids* are large, except in Gulo. The *Pterygoids* are generally perforated by the ectocarotids (except in Melidæ). The skull of Meles taxus (Badger) is remarkable for the closeness with which the transverse condyles of the lower jaw are grasped by the borders of the articular grooves at the base of the zygomatic processes.

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* Marsupialia-Dasyuridæ.

† This being the case in the Plantigrade Bears that do not move by bounds, and in the Pinnigrade Seals, that can only shuffle along the ground, as well as in the typical Digitigrade Felidæ, tends to refute the theory that the final cause of these ossifications is to prevent the concussion of the several parts of the brain against one another when the creature leaps or bounds.

Pinnigrada. The *temporal ridges* often meet upon the sagittal suture (exc. Cystophora), but seldom form more than a very slight crest (exc. Otaria). The *malar* is frequently joined by the zygoma to bound the orbit posteriorly (exc. Trichæcus). The *Lachrymals* are wanting. There are no 'bullæ' in Otaria or Trichæcus. The *Paroccipitals* are generally distinct from the *Mastoids*: the latter are often largely developed, especially in Trichæcus, in which their great development causes considerable lateral expansion in the hinder part of the skull. The *Pterygoids* are seldom perforated for the ecto-carotids (exc. Arctocephalus, Otaria, Trichæcus). Persistent *fontanelles* are commonly present in the occipital. The *Palate* has commonly a semi-elliptic boundary posteriorly, but in Otaria it is truncate, and in Cystophora proboscidea the posterior borders of the palatine bones present three notches. The boundary of the jaw extends from below the condyle forward, and rarely developes an angle.

The *Vertebral Column* is modified in relation to the medium in which the species live, degree of carnivority, and mode of motion. In no Sectorialia do *Cervical* vertebræ articulate by ball-and-socket joints; the seventh C. v. always has the transverse processes imperforate, consisting only of diapophyses. The *Dorso-Lumbar* series numbers twenty vertebræ constantly; the proportion of 'Dorsal' to 'Lumbar' varies with the agility of the species, the most agile Digitigrada having two or three less of free elongated pleurapophyses than the stiffer trunked Plantigrada and Pinnigrada. A similar variation is to be found in the development of Anapophyses, which increase in size directly as the lithe action of the species tends to dislocation of the vertebræ. Lastly, the *Anticlinal* vertebra is more distinctly marked in direct correlation with the development of the anapophyses. In the Planti-, Semi-planti-, and Digiti-grada, the Pro-zygapophysis of one *Lumbar* vertebra is received into the interspace between the post-zygapophysis and the anapophysis of the antecedent vertebra; thus inducing an interlocking articulation.

Digitigrada. In *Leo the spine of the axis* has great height, length, and posterior breadth, arching forward and backward, and overlapping the third V. of which the spine is obsolete: the spine of the fourth V. is short and vertical, indicating the centre of motion of the neck. The anterior *dorsal spines* are lofty and strong for the origin of muscles implanted in the ridged and pitted back part of the skull. The *Lumbar diapophyses* are long and antroverted. The *Sacrum* of *Canis* rufus (fox) is remarkable for its sudden diminution of size, as compared with the lumbar vertebræ. Certain *Viverridæ, e.g.* Paradoxurus (Palm-cat) have the *tail* organised for prehension.

Semi-Plantigrada. In *Lutra* the spines of the three *sacral* vertebræ have coalesced to form a vertical crista, and the tail is longer and stronger than in the terrestrial Mustelidæ.

Plantigrada. The number of true vertebræ is twenty-seven as a rule, and

fourteen of these usually bear moveable ribs. In Ratelus the neural arches of the last five cervical vertebræ are longer than their centra, and overlap each other in an imbricated manner. In Cercoleptes (Kinkajou) the tail is prehensile.

Pinnigrada. The number of true vertebræ is the same as in the Plantigrada. The perforated transverse processes of the third to the sixth *cervicals* inclusive are generally remarkable for the distinctness of their di- and pleur-apophysial parts. The anapophyses form mere rudimental projections from the back part of the diapophyses. The neural arches of the middle dorsal vertebræ are frequently without spines and very narrow, leaving wide intervals of the neural canal unprotected. The manubrium is occasionally (P. Greenlandica) much produced. The *Lumbar* vertebræ have a strong hyp-apophysial ridge which divides into two tuberous processes indicative of the great development of the muscles of the trunk necessary to the shuffling motion of this Sub-order.

The *Scapular arch* and *appendages.* The *Clavicles* are always more or less rudimentary; small clavicular styles* being usually present. The *Scapula* is always broad and has a well developed spine; the *acromion* is developed sometimes simple, sometimes bifurcate; the *coracoid* also varies in size. The *Humerus* is much bent, the articular head lies out of the axis, the deltoid ridge is long and strong; there are strong ridges from the outer and inner sides above the condyles for extending the origins of the muscles of the paw: and the inner condyle is very commonly perforated, to defend the main nerve (median) and artery (brachial) of the fore-leg from compression during the action of those muscles. The *Radius* and *Ulna* are entire, but not always distinct, being fixed when swift course is their principal function. The compound *Scapho-lunar* is common to the Carpus of all Sectorialia. The innermost *Digit* is often stunted or absent.

Digitigrada. All have the clavicular styles. The *humerus* is pierced between the condyles but not above the inner condyle in all (exc. Felidæ, in which the reverse is the case). The *radius* and *ulna* are closely and extensively united in the Canidæ and Hyænidæ. The supplementary ossicle at the radial side of the carpus is present in most Viverridæ and Canidæ. The *pollex*, small in other families, is retained in the Felidæ, and, like the other toes, is terminated by a large, compressed, retractile, unequal phalanx, forming a deep sheath for the firm attachment of the large, curved, and sharp pointed claws.

Semi-Plantigrada. The acromion is generally distinctly bifurcate. The *humerus* in Lutra is remarkable for the compression of the shaft, which is strongly bent forwards.

Plantigrada. The *clavicle* is wholly wanting or very rudimentary. The *scapula* is remarkable for its almost quadrate form, and for the strong development of the ridge between the infraspinatus and teres major, constituting almost

* Ossicles suspended in the muscles and not extending from the acromion to the sternum.

a second spine. The inner condyle of the *humerus* is not perforated, except in Ursus ornatus.

Pinnigrada. There is no trace of a Clavicle. The *humerus* is generally shorter than the scapula: the inner condyle is perforated in Phoca (? alone). The antibrachial bones are compressed and firmly united. The *fore feet* are short and expanded into swimming paddles. The *pollex* or first digit *exceeds* the third, fourth, and fifth in length, but presents its characteristic inferior number of phalanges.

The *Pelvic arch* and *Appendages.* The *Pelvis* varies greatly in the three principal Sub-orders, and so also its appendages; but certain characters appear to be common to each Sub-order, as follows:—

Digitigrada. The *ilia* are long and narrow, but thick: the *ischia* are also long: the *pubis* is short, but the ischio-pubic symphysis long. The whole 'innominate' bone forms a considerable angle with the axis of the lumbar series. The toes alone touch the ground, the heel or calcaneum being much raised. The *hallux* is rudimentary in Viverridæ and Canidæ.

Semi-Plantigrada. Only a part of the hind foot forms a sole to rest on the ground.

Plantigrada. The *ilia* are shorter, thicker, and broader, than in the Digitigrada: the *ischia* are short and expanded, and form with the strong *pubes* a long symphysis: the *femur* is remarkable for its great length, and superficial resemblance to that of Man, though flattened from before backwards. In the Procyon (Raccoon) the *fibula* is characterised by three processes behind its distal end. The *hallux* is rather shorter than the other toes, which are of subequal length, and form the basis of a broad flat foot: the whole of the hind foot forms a sole and rests upon the ground.

Pinnigrada. The Pelvic arch is remarkable for the stunted development of the *ilia*, and the great length of the *ischia* and *pubes*; the symphysis is short, and divaricable in parturition (cf. v.). The *femur* is equally peculiar for its shortness and breadth; the shaft almost disappears and the two articular extremities form nearly the whole mass. The *tibia* and *fibula* are anchylosed at their proximal ends. The bones of the *foot* are much developed, and are modified to form the basis of a large and powerful fin: in Phoca, the middle toe is the shortest, and the rest increase in length to the margins of the foot; in Otaria and Trichæcus the toes are subequal in length. The hind feet are fettered by the continuation of the integument to the tail.

VII.—PROBOSCIDIA.

The *Skull.* The *Sutures* are soon obliterated. The *Frontal* bone is excessively expanded by air cells; as also are the short triangular *Nasals*, with which it coalesces. The *Superoccipital* is much expanded and supports two *Interparietals*, which together with the Parietals, Frontals, and Nasals, form a dome of considerable size: hence the cranial far exceeds the facial area. This dome is however filled almost entirely with contiguous air cells, and only a small proportion of

the back part of the base forms the true brain case. The pneumatic *Maxillaries* are remarkable for the large proportional size of their alveolar part, in advance of which the bone *extends upwards* to be wedged between the Frontal and Premaxillary, *downward* and forward to strengthen the socket of the Tusk, and *backward* to form the anterior pier of the Zygomatic arch and the lower part of the Orbit. The pneumatic *Premaxillary* mainly consists of the part which lodges the base of the great Tusk; but its ascending portion reaches the Frontal, and excludes the Maxillary from the Nasal. The *Epencephalic* compartment of the cerebral cavity is wholly behind the Pros- and Mes-encephalic ones, as is also the case in the Insectivora, Cheiroptera, Rodentia, and Inenamellata.

The *Vertebral Column.* The *Epiphyses* continue detached from the bodies of the Vertebræ to nearly full growth: the Centra are remarkably short for their breadth, especially in the *Cervical* region. The first and fourth *Dorsal* are remarkable for the strength as well as the height of their neural spines. There is no Anticlinal Vertebra in the Dorso-lumbar series. The first and second *Ribs* are almost straight, and expand to join their short sternal parts. Five pair of ribs directly join the sternum, which consists of four bones. Nearly two-thirds of the *Caudal* vertebræ are reduced to the centrum alone.

Anterior Appendages. There are *no Clavicles*: the *Scapula* is broad and concave, and has thick epiphyses attached to the border; a process depends from the short pointed Acromion; the *Glenoid* cavity is shallow; the Coracoid a mere tuberosity. The head of the *Humerus* is sessile; the great tuberosity rising above it and extending antero-posteriorly; each of these has a separate epiphysis. The *Radius,*—crosses obliquely in front of the Ulna to the inner side of the Carpus,—has its head wedged between two processes of the Ulna, —and has its expanded distal half attached by a ligament to the Ulna. The Feet have five toes, which are outwardly indicated only by divisions of the hoof.

Posterior Appendages. The *Ilium* on each side is but narrowly apposed, by the edge, to the three Sacral vertebræ, and stands out from them so that its principal axis forms a right angle with the axis of the Vertebral Column. The *Ischia* and *Pubes* are short, and form a symphysis, the axis of which is parallel with that of the vertebral column. The Great Trochanter does not rise so high as

the head of the *Femur ;* the small one is almost obsolete. The *Tibia* and *Fibula* are distinct throughout their length.

In the Proboscidia the following characters recall the '*Rodent*' type, *viz.* :—the *epencephalic* wholly behind the pros- and mes-encephalic cerebral cavities ;—the *malar* bone suspended in the middle of the zygomatic arch ;—the *præmaxillaries* large and excluding the maxillary from the nasal ;—the large alveoli for the single pair of incisors : lastly—the spine of the *scapula* extended into a short pointed acromion and sending down a process.

VIII.—PERISSODACTYLA.

The *Skull.* The *Nasals* expand posteriorly. The slender *Pterygoid* process has a broad and thick base, and is perforated lengthwise by the ectocarotid artery. The major part of the *Posterior Aperture of the Nostrils* is bounded by the *Palatine* bones of which only a small portion enter into the formation of the bony palate ; the *Bony Palate* terminates behind, generally in the neighbourhood of the *penultimate Molar* tooth. The *Post-tympanic* process is well developed. The Jaws are long and slender. If the species be horned the *Horn* is usual[illegible] *vubes* a but if there be two, they are of unequal size, and placed on the median line of the head, one behind the other ; each being thus a single or odd horn.

Solidungula. The roof of the *orbit* is produced outwardly and the osseous framework is *completed* posteriorly by the junction of the post-orbital with the zygoma. The base of the post-orbital process is perforated for the *superorbital foramen.* The *lachrymal canal* begins by a *single* foramen. The *Præmaxillaries* extend to the *nasals,* which are very long and conspicuous, and shut out the *maxillaries* from the anterior aperture of the nostrils. The *post-tympanic* process is separated from the *paroccipital* process by the intervention of the tuberous *mastoid.* The *tentorium* is ossified.

Multungula. The *orbit* is incomplete. The *superorbital* foramen is absent. The *lachrymal canal* commences by *two* distinct orifices. The *præmaxillaries* terminate before reaching the *nasals.* The *post-tympanic* process either unites with the lower part of the paroccipital, *e.g.,* in Tapir ; or, seems to take the place of the mastoid, *e.g.* in Rhinoceros.

The *Vertebral Column.* In both the *Cervical* and *Dorsal* vertebræ the fore part of the centrum is convex, the hind part concave, *i.e.* the joints of the centra are *Opisthocœlian.* The *Dorso-lumbar* vertebræ are never fewer than twenty-two. There are commonly eight pair of *Ribs* directly joined to the Sternum which consists of seven bones and a xiphoid cartilage. The *Sacral* vertebræ are frequently five or six in number, but of these only two or three articulate with the Ilia.

The *Scapular Arch and Appendages.* There is no power of Rotation of the Fore Limb in any Hoofed Quadruped. There are no *Clavicles.* The *Scapula* is long in proportion to its breadth; its spine developes no Acromion: the *Coracoid* is a mere tuberosity The *Humerus* is remarkable for the size and strength of the proximal tuberosities. The *Os Magnum*, and the Digitus Medius (iii.) which it supports, are largely developed.

Solidungula. The *ulna*, represented by its well developed olecranal extremity, is confluent with the radius in its proximal moiety. *Digits* iv. and ii. are rudimental, and digit iii. alone encased in a Hoof.

Multungula. The *radius* and *ulna* sometimes interlock, *e.g.* in Rhinoceros, sometimes partially coalesce at their distal ends, *e.g.* in Tapirus. *Digits* ii., iii., and iv. are fully developed, and each encased in a Hoof. In *Tapir*, the first or trapezial digit is the only one absent; and that articulated to the Magnum, answering to the third, is the largest, and of symmetrical shape; the whole forefoot plainly showing the Perissodactyle type, though with four toes.

Pelvic Arch and Appendages. The *Ilium* is generally rather hammer-shaped, and articulates by its superior angle with two or three of the sacral vertebræ. The Ischium is produced backwards considerably. The *Femur* has a third trochanter: and the medullary artery penetrates the middle third of the back part of the shaft; it has no constriction between the head and shaft.

Solidungula. The *fibula* is as rudimentary as the *ulna.*

Multungula. The *fibula* is fully developed.

IX.—HYRACOIDEA.

The *Skull.* The elements of the *Occipital* bone are late in coalescing. An *Interparietal* is present in the back part of the sagittal suture. The ascending process of the *Malar* articulates with the post-orbital process which is formed by both Parietal and Frontal bones. The Tympanic, which forms the Bulla Ossea at the basis cranii, has not coalesced with the Petrosal. The hinder halves of the *Palatines* enter into the formation of the Palato-Nares. The *Lachrymal canal* commences by one or two foramina, protected by a process. The *Maxillary* forms the floor of the orbit as in Perissodactyla Multungula; but the premaxillaries join the nasals. The *Lower Jaw* is remarkable for the backward expanse of the ascending Ramus. The Coronoid process is perforated lengthwise at its base.

The *Vertebral Column.* There are not fewer than twenty-nine or thirty Dorso-Lumbar Vertebræ: the *Dorsals* in their form and proportions resemble those of the Rhinoceros: the *Metapophysis* exceeds

the Diapophysis in length in all the posterior dorsals: no *Anapophyses* are developed. In the eighth *Lumbar* vertebra the Diapophyses suddenly acquire great breadth, and gradually increase in length to the last lumbar. The first three *Sacral* vertebræ articulate with the ilia.

The *Limb Bones.* There are no *Clavicles.* The Intercondyloid part of the *Humerus* is perforated (as in the Tapir). The *Fore Foot* is unsymmetrically tetradactyle: the *Hind Foot* has only three toes.

X.—ARTIODACTYLA.

The *Skull.* If the species be horned, the *Horns* form one pair or two pair; they are never developed singly, of symmetrical form, from the median line. The *Nasals* are usually long and conspicuous, and do not expand posteriorly. The *Lachrymal* is very large, especially in its facial part. The *Super-orbital* canals are large in most species. The *Præ-maxillaries* generally reach to, or are contiguous with, the Nasals. The *Post-tympanic* does not project downward distinctly from the *Mastoid,* nor supersede it; and the *Par-occipital* always exceeds both these processes in length. The *Bony Palate* usually extends further back than in the Perissodactyles: the hinder aperture of the *Nasal passages* being more vertical, and commencing *posterior to the last molar* tooth. The base of the *Pterygoid process* is not perforated by the ectocarotid artery.

Omnivora. The *orbit* is seldom complete: the *præmaxillaries* reach the nasals: the *malar* rarely reaches the frontal: the *temporal fossæ* are deep and approximate on the top of the cranium: the *zygomatic* arch is strong: the articular condyle of the *jaw* is larger than in Ruminantia. In *Hippopotamus* the rim of the orbit is almost, sometimes quite, complete: the lateral series of molar alveoli slightly diverge anteriorly: the basi-occipital forms no part of the occipital condyles: each ramus has an antroverted angular process. Most of the *Suidæ* have a prænasal bone.

Ruminantia. Processes are generally found on the frontal bone for horn core. The *parietals* are frequently anchylosed together: the malar and frontal bones generally complete the *orbit.* The articular condyle of the *jaw* is small, and plays freely in all directions in a shallow glenoid cavity: the coronoid processes are narrow, and the base of the ascending ramus expanded. The *temporal fossæ* are small:—the *zygomatic* arch weak:—the *præmaxillaries* generally edentulous. The *Hyoid* arch includes long, compressed, hammer-shaped 'stylohyals' attached to short epi- and cerato-hyals: the thyro-hyals are also small; the basi-hyals normal. [In *Camelus* no processes are developed from the frontal bone for horns: the Zygomatic arches, in relation to the laniariform teeth, are long and overspan a wider temporal fossa than in the true Ruminantia: the Præmaxillaries do *not reach* the nasals: the orbital plate of the Lachrymal shows two perforations:

the angle of the Mandible is singularly elevated: and the palate extends as far back as in the horse]. In *Solidi-cornua* the Horn cores are osseous, their bases sometimes resting equally upon the parietals and frontals: the Lachrymal is separated from the nasal by a large vacuity which intervenes between them, the frontal, and the maxillary. [In *Giraffa* the articular surface of the prominent occipital Condyles is so extended vertically as to admit of the head being raised in a line with the neck: the Exoccipitals are largely developed for the ligamentum nuchæ. In *Cervidæ* the Lachrymal is provided with a deep pit and groove for the reception of the sebaceous sacs]. In the *Cavi-cornua* the Bovidæ frequently have Persistent Sutures between the exoccipitals, and between these and the Superoccipital: the Occipital Condyles are wide apart: the Paroccipital descends much below the Mastoid: the Malar generally extends largely upon the face: the Nasals are frequently cleft anteriorly: the Frontals form the chief part of, and alone develope the Horn cores (exc. in Antelopes): a Lachrymal pit is commonly found.

The *Vertebral Column.* The *Dorso-lumbar* series generally numbers nineteen, except in Antilopidæ and Ovidæ.

Omnivora. The *Pleurapophysial* parts of the transverse processes of the posterior *Cervicals* generally develope hatchet-shaped plates or lamellæ, which progressively increase in size posteriorly, and overlap each other.

Ruminantia. The *Cervical* vertebræ have opisthocælian ball and socket joints: the seventh cervical always has the transverse process imperforate: the anterior *Dorsals* have long spines for the attachment of the ligamentum nuchæ: the diapophyses of the last *lumbar* vertebra do not articulate with the sacrum. The *Camelidæ* have a remarkably long and flexible cervical region; but the typical number of vertebræ remains: the transverse processes of their cervical vertebræ are never perforated for the vertebral artery*: their last sternal bone is greatly expanded and protuberant below to support the pectoral callosity. The Giraffe has the longest cervical vertebræ of all mammals.

The *Scapular Arch and Appendages. Clavicles* are wanting. The spine of the Scapula is commonly produced into an acromial angle. In the *Carpus* the os magnum does not exceed, and may be less than the unciform. The Limbs are terminated by *Feet* with four or two toes, the digit answering to the iii. in the penta-dactyle foot is unsymmetrical, and forms with that answering to the iv., a symmetrical pair.

Omnivora. The *Scapula* is short as compared with that of Ruminantia, and the acromion is sometimes deficient, *e g.* in Sus scrofa. The *Radius* and *Ulna* are generally coalesced, *e.g.* in Hippopotamus; sometimes distinct, though in close proximity, *e.g.* in Sus.

Ruminantia. In the true Ruminantia the spine of the *Scapula* is not produced, but terminates in an acute (Bos), or a right angle (Cervus): in Camelidæ, on the contrary, it is produced. The *Metacarpals* coalesce early into a single bone, but

* The vertebral artery in the Camelidæ transverses the neurapophyses.

the medullary canal of each remains distinct; each moiety has its distinct distal trochlea and phalanges; and in each of them the second phalanx is modified to be sheathed in a hoof: stunted portions of the other toes are to be found in most true Ruminantia suspended to the back part of the distal end of the so-called 'cannon' bone, as 'spurious hoofs,' not reaching the ground.

The *Pelvic Arch and Appendages.* The *Ischia* are long, and with the dorsal angles of the broad and thick tuberosities produced towards the caudal vertebræ. The *Femur* never has a third trochanter: the *Medullary artery*, except in the Camelidæ, enters the *fore* part of the shaft usually in its upper third: the inner border of the rotular channel never developes an irregular prominence (as in Perissodactyla) though here produced. In the *Carpus* the Ectocuneiform is less, or not larger than the Cuboid: the Cuboid and Naviculare are distinct bones in all except the restricted or horned Ruminants.

Omnivora. The *Tibia* and *Fibula* are generally distinct. In Dicotyles (Peccari) the fifth as well as the first toe are wanting in the hind foot: the second toe is small; the third and fourth are very large, and form a symmetrical pair, showing that the Artiodactyle structure essentially prevails, although the toes, by the non-development of the fifth, are, exceptionally, reduced to three in number.

Ruminantia. The *Os innominatum* is elongate, with the iliac portion concave lengthwise, convex across, externally, with the expanded anterior end divided by a ridge into two portions articulating with sacrum. The *Ischium* extends back from the acetabulum with the tuberosity bending upwards. The *Pubes* are slender. The *Hind Limbs* always exceed the fore limbs in length. The shaft of the *Fibula* exists as a sclerous tissue in all Ruminantia. The *Naviculare* or Scaphoid is almost always *confluent with the Cuboid.* The *Metatarsal* segment is generally represented by the third and fourth metatarsals confluent: the distal ends of the second and fifth being ossified and supporting the small digits terminated by the 'spurious hoofs.' [In the *Camelidæ* the scapula is broader than in horned Ruminantia, and has its spine produced: the scaphoid is not confluent with the cuboid: the canal for the medullary artery enters the *back* part of the shaft of the femur; the borders of the rotular channel are subequal.]

XI.—CETE.

The *Skull* is large, the size being due in most Cete to the development of the jaws, which in some Whales (*e.g.* Balænidæ, and Physeter macrocephalus) is excessive. The Skull of the Balænidæ is more symmetrical than that of the toothed Cete. The *Mastoids* are always distinct from the Petrosals. The *Tympanic* generally presents a peculiar conchoidal shape, and is extremely dense in texture. *Lachrymal* bones are generally absent. The *Cribriform plate* is also usually rudimentary, or absent (Physeter). The *Nasal* bones are short, rudimentary, or absent (Physeter). The *Frontal* bones fre-

quently assume the form of triangular plates with the outer and fore angle produced into a superorbital process: they are joined to contiguous bones by squamous suture. The bone formed by the coalesced *Prefrontals* (Physeter) penetrates the posterior part of the groove of the vomer, and expands above it, forming the septum of the *vertical nasal passage;* it is not complicated with *Turbinal* or Rhinal capsules, as in the so-called 'Ethmoid' of the other Mammals. The *Malar* is generally small and slender. The *Condyle of the Mandible projects from the posterior* part of the base or ascending ramus. In some Cete the Pterygoid processes of the *Sphenoid* remain separated throughout life. In Delphinus a bony *Tentorium* is found. In Physeter the capacious basin on the upper surface of the skull, which lodges the valuable produce called 'spermaceti,' is formed by the expanded and concave nasal processes of the Præmaxillaries and Maxillaries which overlap the Frontals. In the mature Balæna mysticetus, the Maxillaries are disposed each like an expanded arch along the outside of the co-extended Præmaxillaries; their inferior surfaces have two facets, separated by longitudinal ridges, to the sides of which the plates of baleen are attached.

The *Vertebral Column.* The discoid terminal Epiphyses long retain their individuality, especially in Balæna. There are no *Anapophyses.* The *Cervical* region is short; the Cervical vertebræ are always seven in number, but each is flattened from before backwards into a broad thin plate, and partly anchylosed with its fellow on either side (except in Narwhal in which they are all free), and thus rendered almost incapable of movement on one another: indeed in most of the true Whales (Balæna), Grampus, and Porpoise, the Cervical vertebræ are blended together into a single bone. In many species of this group the second Cervical vertebra lacks the Odontoid process. The number of *Ribs* directly articulating with the Sternum is variable. The *Hæmapophyses,* by which the Pleurapophyses or Ribs are joined to the Sternum, are commonly cartilaginous, rarely osseous. The number of the component bones of the Sternum is also variable. The *Sternum* of the *Whale* consists of but *one* short and broad bone, to which is usually connected a single pair of Ribs. The vertebræ without Ribs succeeding to the Dorsal are many in number, and, since they are as free from anchylosis as in Fishes, cannot be differentiated into 'lumbar' and 'sacral.' The *Sacrum is never indicated by vertebral confluence,* and only obscurely by the position of the Pelvic rudiments loosely suspended below. The *Caudal* vertebræ

are distinguished by the 'chevron bones,' *viz.*, hæmapophyses articulated in Cete, as in Crocodilia, directly to the under surface of the centrum and coalesced at the opposite ends, thus forming a hæmal canal analogous to, but not homologous with, that in Fishes. The Caudal vertebræ of Whales further differ from those in Fishes, in retaining the transverse processes, and in becoming flattened from above downwards without coalescing.

Anterior Appendages. The Anterior Limbs alone are developed, and are flat and fin-like. The *Clavicles* are wanting. The *Scapula* is broad, flat, and without a spine along the outer surface; it has a short stunted Coracoid anchylosed to it, and is freely suspended in the flesh (*cf.* Fish). The *Humerus* is remarkably short in proportion to its thickness, as in most Aquatic Mammalia. There is no complete articulation between the bones of the Fore-arm and the Humerus. The Olecranon, though generally present, is but slightly developed. The two short bones of the Fore-arm lie immoveably behind each other, and are very flat. There is no complete articulation between the bones of the Carpus, Fore-arm and Digits. The *Carpal* bones are generally three to five in number, dice-shaped, and lying between thick tendons and masses of ligament. *Some of the Digits have more than three phalanges;* in the Whales five to six, and in the Dolphins even more. All the Digits in the natural state are enveloped in a common fold of integument. The increase of the Phalanges of certain Digits beyond the number three is a remarkable instance of departure from the Mammalian type, and of affinity with the extinct En-alio-saurus and Fishes.

Posterior Appendages. The *Pelvic* bones consist of two simple elongated bones, lying near the anal and generative organs, which converge together from opposite sides, or are connected by a transverse piece: these *traces of Innominate bones* are remote from the vertebral column and connected with the rest of the skeleton by muscles only. There is never more than a *trace of hind limbs;* these, when found, are represented (*e.g.* in the Right Whale) by a two-jointed ray. This is the simplest condition of the limb, or appendage, of the Pelvic Arch known in the Mammalian Class.

XII.—SIRENIA.

All the bones of the skeleton are solid.

The *Skull.* The Facial, or rostral parts of the skull, anterior to the orbits, is short. All the skull bones are massive, and, save in

the instances of anchylosis, are somewhat loosely connected together. The *Frontals* are not confluent. *No distinct Nasals* are found anterior to the frontal suture. The *Præmaxillaries* of the Dugong (Halichore) are remarkable for their very large and long deflected alveolar portion. The *Zygoma* is unusually massive. The Basisphenoid coalesces with the Alisphenoids; the Præsphenoid similarly coalesces with the Orbitosphenoids, and is wedged between the laminæ of the Vomer as a compressed 'rostrum.'

The *Vertebral Column.* The *Cervical* region is short, but longer in proportion than in the Cete. The cervical vertebræ are generally free (*cf.* Cete) and short. *In the Manatee and in the extinct Rhytina* (of Steller) *they are but six in number;* thus forming an exception to the generally constant number (seven) of cervical vertebræ. The *Ribs* of the dorsal vertebræ are massive, and join by cartilaginous hæmapophyses the sternum, which in the immature state is made up of two bones. There is no distinction of 'Lumbar' and 'Sacral' vertebræ. Most of the *Caudal* vertebræ have long diapophyses and hæmal arches.

Scapular Arch and Appendages. The *Clavicles* are wanting. The Pectoral pair of limbs alone exist, and their supporting arch is reduced to the *Scapula,* which has a short Coracoid process. The *Humerus* has the normal Mammalian character, and a synovial articulation (*cf.* Cete), with the Radius and Ulna; the latter of these bones developes an obtuse olecranon. The *Phalanges* are never more than three in number.

The *Pelvic Arch.* The *Pelvis* assumes the Batrachian condition,* and *all appendages to the rudiment of the Pelvic Arch are wanting.*

XIII.—IN-ENAMELLATA.

The *Skull* in the Insect-eating† In-Enamellata is long and slender, these proportions reaching their extreme in the true Ant Eaters (Myrmecophaga), owing to the great development of the facial part. In the Bradypodidæ, on the contrary, the whole head is proportionally small, the facial part of the skull being exceptionally short. The *cranial cavity* is throughout this order of small proportional size. The *Zygomatic arch* culminates in regard to complexity in the Bradypodidæ, albeit in the small existing species, as also in the Ant Eaters,

* The Pelvic bones appear to be entirely wanting in Manatus.

† The *Insect-eating In-Enamellata* are the edentulous *Myrmecophagidæ* and the *Dasypodidæ.*

the squamosal element fails to reach the malar one. The ***Malar*** bone is remarkable in Bradypus for its size, shape, and connections; it is freely suspended by its anterior attachment to the maxillary and frontal, and bifurcates behind; one division extending downwards, outside the lower jaw, the other ascending above the free termination of the zygomatic process of the squamosal. The *Intermaxillaries* are very small in most species of this Order, and support teeth only in the six-banded Armadillo. The *Pterygoids* are frequently inflated in the Bradypodidæ.

The *Vertebral Column.*—In no other Mammalian order are found such *complex vertebral articulations; e.g.* In the Dasypodidæ the metapophysis presents an articular surface at the under and fore part of its base, to be articulated with an anapophysis of the succeeding vertebra: and again the anapophyses upon the last dorsal, each present an articular surface at the under part for connection with the parapophyses. In this order alone are manifested the exceptional instances of *affinity to certain Ovipara,* in the lower cervicals with free ribs of the three-toed, and in the twenty-three costigerous dorsals of the two-toed Sloths. The three-toed Sloths* (*Bradypus tridactylus*) *have nine cervical vertebræ;* and Cholæpus† Hoffmannii *has but six cervical vertebræ;* two out of the four so-called exceptions to the rule of there being always seven cervical vertebræ in Mammalia.‡ In the Loricate or *Armadillo* family (Dasypodidæ) the vertebral column is remarkable for the *prevalence of anchylosis* in unusual parts, *e g.* the cervical region; and for the great size to which the *metapophyses* attain (in the lumbar region especially). The metapophyses (which are processes from the anterior zygapophyses) serve, together with the neural spines, to support the Carapace. The *Sloth* and *Armadillo* have *ossified hæmapophyses.* The *spines* of the *Sacral vertebræ* are very commonly anchylosed. In Dasypus the Sacrum is exceedingly broad, and anchylosed inferiorly to the Pelvis. Dasypus forms an exception to the rule of absence of anchylosis in the caudal region.

Scapular Arch and Appendages. The *Scapula* in the Armadillos and true Ant Eaters is broad, and presents *two spines* (in Manis it has only one spine), and the acromion is long. *Clavicles* are present

* Bradypus torquatus is said to have *eight* cervical vertebræ.

† *Cholæpus:* the genus of *two-toed Sloths.*

‡ See *Sirenia.*

in all Dasypodidæ and Cholæpus; are small and rudimentary in Myrmecophagidæ, absent in Manis, and so short as not to reach the sternum in the Sloth. The *Humerus* is generally well developed, short and broad in the Armadillo, long in the Sloth, varying, as also do the Antibrachial bones, with the burrowing or climbing habits of the different species: it is generally perforated above the inner condyle‡. The *Ulna* is generally longer (ex. Manis) than the Radius, often much stronger (*e.g.* Armadillo), and usually possessed of a well-developed Olecranon. In all In-Enamellata the *Radius* is free, and rotates on the Ulna: in the Sloth these bones are so articulated as to allow of pronation and supination. The *Metacarpal bones* in the Sloth are united together posteriorly, and also with the front row of Phalangeal bones. The *Ungual Phalanx* of the Ant Eater is characterised by being split at the extremity by a longitudinal fissure, commencing at the upper part of the base (*cf.* Perameles, Marsupialia).

Pelvic Arch and Appendages. The *Ischia* are largely developed in all except the Sloths: and except in Orycteropus *unite with the vertebral column.* The *Ilia* are generally firmly and extensively united with the Sacrum. The *Pubes* are always slender, and form but a narrow ossified symphysis. The large Pelvis, the union of the Ischia with the Sacrum, and the speedy osseous confluence of the several pelvic elements are common characteristics of the spinal column of the In-Enamellata. The *Armadillos* are marked off from the Sloth and Ant Eaters by having a third trochanter to the Femur, and the proximal and distal extremities of the *Tibia* and *Fibula conate.* In both Sloth and Ant Eaters, the Tibia and Fibula are distinct (in the former they are oppositely bent, leaving a wide interosseous space), and both fore and hind feet have an inclination inwards, owing in the latter case to the downward projection of the outer Malleolus, which fits like a pivot into a socket in the Astragalus.

XIV.—MARSUPIALIA.

The *Skull* is generally more depressed and flattened than in the Placental Mammalia; and is remarkable for the small proportion which is devoted to the protection of the brain, and for the great expansion of the nasal cavity immediately anterior to the cranial cavity: it usually converges gradually towards the anterior ex-

‡ Except Manis.

tremity. In the stronger carnivorous Marsupials the exterior of the cranium is characterised by bony ridges and muscular impressions, varying directly with the development of the temporal muscles, the extreme development being found in the Virginian Opossum, in which the sides of the cranium meet above at an acute angle, and send upward from the line of their union a remarkable elevated sagittal crest, which, in mature skulls, is proportionally more developed than in any of the Placental Sectorialia. In the smaller Herbivorous and Insectivorous species the cranium presents a convex surface, as in birds.

The *Occipital* region, which is generally plain, and vertical in position, forms a right angle with the upper surface of the skull, from which it is separated by an occipital, or lamboidal crista. The elements of the occipital neural arch remain longer distinct in Marsupials than in most other Mammals. The *Condyles* are each perforated anteriorly by two foramina in most of the Marsupialia. The *Foramen magnum* is of great size in relation to the capacity of the cranium. The *Sagittal suture*, between the Parietals, is obliterated in those species in which a bony crista is developed, as also in some aged animals. An *Interparietal bone* is generally present. The *Coronal suture* presents, in most of the Marsupialia, an irregular angular course, forming a notch in the frontals on each side, and receiving a corresponding triangular process of each frontal bone. The *Frontals* are chiefly remarkable for their anterior expansion and the great share which they take in the formation of the nasal cavity. The *Extraorbital foramen* is a good Marsupial character. The most characteristic structure of the *Nasal* bones is the expansion of their upper and posterior extremity. The *Præmaxillaries* always contain teeth, and the ratio of the development of these bones corresponds with the bulk of the dental apparatus which they support, they are consequently largest in the Wombat. The *Malars* are generally very strong, and of great extent. The *Zygomatic arches* are always complete, and usually strongly developed, but do not vary in size as directly with the diet as in preceding orders. Most Marsupials have a *Sphenoidal bulla*, formed by the expansion of the base of the Sphenoid; Acrobates and Perameles lagotis have a second bulla formed by the expansion of the Petrous bone; the *Petrous bone* is generally of small size, and limited to the office of protecting the parts of the internal ear; the *Glenoid cavity* presents a characteristic structure in most of the Marsupials in not being exclusively

formed by the Squamosal; but presents various forms in direct correlation with the structure of the teeth, and the movement required of the jaw. The *angle of the Jaw* is as if it were *bent inward*,* in the form of a process. On looking directly upon the lower margin of the jaw, in place of the margin of a vertical plate of bone there is seen a more or less triangular surface, extended between the external ridge and the internal process, or inflected angle (esp. in Wombat).† In all those Marsupialia which have few or very small incisors the horizontal rami converge towards a point, the symphysis being more or less complete. The *Nasal cavity* communicates with the mouth by means of various large vacuities in the palatal processes. Two *posterior Palatal Foramina* are generally present, of variable size and position, especially noticeable in Perameles lagotis, in which the bony roof of the mouth is perforated by a wide oval space, exposing to view the Vomer and the convolutions of the inferior Spongy bones in the nasal cavity. The *Pterygoids* long maintain their individuality, and are always small and lamelliform. The *Entocarotid* canals pierce the *Basisphenoid*, as in Birds. The *Tentorium* is sometimes partially, but never completely ossified in any of the Marsupialia. There is no ossification of the *Falx*, as found in Ornithorhynchus (*cf.* Monotremata). There is no distinct *pituitary fossa*, nor Clinoid processes. The *Optic foramen* is confluent with the sphenoidal fissure.

The *Vertebral Column*.—The inferior arch of the *Atlas* frequently remains permanently open in the middle line below (*e.g.* Phascolomys, Phascolarctos, Phalangista, and Macropus). This opening is generally occupied, in carnivorous Marsupialia and in Thylacinus, by a distinct, and separate ossification. In all Marsupialia the *spine of the Dentata* is well developed, both in the vertical and longitudinal directions. The *transverse processes* of the *Cervical* vertebræ are generally more or less expanded nearly in the axis of the spine, so that the posterior part of one transverse process overlaps the anterior part of the succeeding. The spine of the first *Dorsal* is generally considerably longer than that of the last cervical, and all the spines generally slope towards the centre of motion. The *Ribs* consist of bony pleurapophyses, and gristly hæmapophyses, which acquire bone earth

* Except Tarsipes.

† The outer surface of the *ascending ramus* is imperforate in the Dasyuridæ, Didelphydæ, Peramelidæ, and Phalangistidæ; but in the *Phascolomydæ* and *Macropidæ* it is directly *perforated* by a round aperture immediately posterior, or opposite to the commencement of the dental canal.

only in the aged. In the *Lumbar* vertebræ the metapophyses attain a great size. The number of vertebræ succeeding the lumbar, which are anchylosed together in the *Sacral* region of the spine, varies from seven, in Wombat, to one, in Perameles: usually but one vertebra supports the iliac bones. In most of the Marsupialia which have a long *Tail*, whether used to support or suspend the body, V-shaped bones are found beneath the *articulations* of most of the caudal vertebræ, which serve to protect the blood vessels.

The *Scapular Arch* and *Appendages.*—The *Scapula* varies in form; the *coracoid* exists as a *process of the scapula*, being anchylosed with it, as in the higher Mammalia, and not articulating with the Sternum. The Subscapular area is generally more or less convex, or undulating. The *Clavicles* are present in all except Perameles and Chæropus (?); are strongest and longest in the burrowing Wombat, weakest and shortest in the great Kangaroo. In almost all, the internal *condyle of the Humerus* is perforated. The *Radius* and *Ulna* are always distinct and well developed, but run nearly parallel and close together. The olecranon is always well developed. There is not any digit situated like a thumb, but *all the fingers enjoy lateral motion*, and those at the outer side can be opposed to those at the inner side, so as to grasp an object. The long ungual phalanges of the Peramelidæ are cleft mesially. Chæropus has a manus much resembling that of the Artiodactyla, but differing from it in having digits ii. and iii. functional instead of iii. and iv.

The *Pelvic Arch and Appendages*, &c.—The *Pelvis* in the mature Marsupial is composed of the os sacrum, the two ossa innominata, and the characteristic supplemental bones attached to the pelvis, called the *ossa Marsupialia;* these last being ossifications of the internal tendon of the external oblique muscle of the abdomen.* The *length of the symphysis of the Ischia* (or the lower part of what is commonly called the symphysis pubis), and the *straight line formed by the lower margin of the Ischia*, is a characteristic structure of the pelvis in most Marsupialia. The shaft of the *Femur* presents no linea aspera, the head is supported on a very short neck. The *internal Malleolus* is very slightly produced in any Marsupial. The *Fibula* is well developed. In the Scansorial and Gradatorial Marsupialia the bones of the anterior and posterior extremities are of nearly equal length; but

* These bones have no special function relating to the ventral pouch of the female, being nearly equally developed in both sexes, and also in those species in which the Marsupium is not present.—*Flower.*

in the Saltatory species the disproportion in the development of the bones of the hind leg is very great. In the Saltatory species the Fibula is in close contact with or attached to the Tibia, so as to ensure fixity and strength: in others the Tibia and Fibula are so loosely connected together, and with the Tarsus, that the foot enjoys a movement of rotation analogous to that of the hand. A *degeneration of the Foot*, common to many Marsupials, is to be observed in the *slender condition of the second and third toes*, as compared with the fourth and fifth, and their enclosure nearly to their extremities in a common integument: in the Saltatorial genera they are reduced to almost filamentary slenderness. This condition of the Pes called syndactylism prevails in all Marsupials, except the Didelphidæ, Dasyuridæ, and Phascolomyidæ. In most of the Plant-eating Marsupials no rudiment of the innermost toe exists.

XV.—MONOTREMATA.

The Skull.—The Monotremata differ from the Marsupialia in the *absence of the inflected process* developed from the angle *of the lower Jaw*. The Skull is long and low, the facial bones projecting in a more or less beak-like form. The *Sutures* between the cranial bones are early *obliterated.* The *Frontal* bones expand as they rise, but do not develope supra-orbital ridges. The *Malar and Squamosal* bones are *confluent* (unless the slender process of the maxillary may represent the malar). The *Lachrymals*, also, are *confluent* with adjacent bones. The *Pterygoid* processes of the Sphenoid often remain separated throughout life. The Pterygoids are flattened, horizontal, oval plates, attached to the obliquely truncated postero-external extremities of the Palatines, and form part of the floor and the inner wall of the tympanic cavity, an arrangement not met with in any other Mammal. The *Stapes* is columelliform; one crus of the *incus* anchyloses with the reduced tympanic, the other is confluent with the *malleus*. In many of these points the *Ornithic affinity* of this order is apparent. In no Mammal is the *proportionate size of the lower Jaw* as compared with the skull so *small* as *in Echidna*, in which it consists of two long styliform rami, loosely connected anteriorly, and bound up with the superior mandible in a continuous sheath of skin, except just at the apex. The lower jaw of Ornithorhyncus, on the contrary, resembles very much a flattened duck's bill; it consists of two horizontal rami, united in the middle of their length, diverging anteriorly and posteriorly from that point,

and terminating towards the snout, as expanded spatulate processes. In both species the Coronoid process and the angle of the jaw are rudimentary. Echidna has a well developed cribriform plate, but in Ornithorhyncus the olfactory nerve escapes by a single foramen (Sauroid affinity). Lastly, we may note the *bony falx found in Ornithorhyncus* only of this order (and rarely found in other orders) attached internally to the middle line of the coalesced parietals.

The Vertebral column.—The pleurapophyses in the *Cervical* region retain their individuality. In Ornithorhyncus (but not in Echidna) hypapophyses are present in the cervical vertebræ; and are bifurcated in Atlas. The hæmapophyses* of the first six *Dorsal* vertebræ are ossified, and have cartilage interposed between them and the pleurapophyses,† as in the Crocodile: the rest of the hæmapophyses are cartilaginous, and overlap each other. A small tubercle defines the neck of the *Rib* save in the last four, but save in the first and second, the Ribs do not articulate with the diapophyses, but only with the centra of the vertebræ *below the neuro-central* suture, the reverse of what occurs in the higher Mammals. The *Præsternum* or Manubrium is divided by an intervening layer of cartilage into two parts: of these the posterior, or pleur-osteon, receives the hæmapophyses of the first and second Ribs; while the anterior, or pro-osteon, is in relation with the Coracoids and Epicoracoids superiorly, and with the body of the large T-shaped Inter-clavicle [*Episternum*, Owen] (on which the Clavicles are superposed) inferiorly. In Ornithorhyncus the Sacral vertebræ remain permanently separated. In Echidna the fluid central part of the intervertebral substance fills a more definite cavity than in higher Mammalia; and none of the Cervical vertebræ have zygapophyses except the atlas. The *Caudal* vertebræ seldom have hæmapophyses articulated to the vertebral interspaces, as in many Marsupials. The spinal nerves usually *perforate* the neurapophyses.‡

The *Scapular Arch and Appendages.*—The *Scapular Arch* is arranged according to the type of the Sauropsida. The *Scapula* is long, and sabre-shaped. The *Coracoid*, which in this order alone of Mammalia attains its normal proportion, is developed as a distinct bone, and extends from the Scapula to the Interclavicle, and also to

* Sternal Ribs. † Vertebral Ribs.

‡ The same arrangement obtains in Bovidæ, and Tapir.

§ The *Epicoracoid* is a flat shield-like plate of bone, placed in front of the inner end of the Coracoid, the rounded inner border of which passes beyond the median line, overlapping the corresponding bone of the opposite side.—*Flower.*

the Pro-osteon, with both of which it is in relation, as in Birds and most Reptiles; it is anchylosed at full growth with the Scapula. The *Epi-coracoid*§ (as in Lizards) articulated with the anterior margin of the Coracoid is also an osteological characteristic of this order. The *Clavicles* are represented by two curved styles, extending from the acromion along the transverse arms of the Interclavicle. In this Order alone of all the Mammalia are the *Interclavicles* found. The *Humerus* is remarkable for its shortness and breadth; both condyles are remarkably produced, especially the internal one, which is perforated. The *Radius* and *Ulna* are pretty firmly connected together through nearly the whole extent, the ulna being chiefly remarkable for the olecranon, which is bent forwards upon the humerus and transversely expanded at its extremity. The number of *Phalanges* is the same as in other Mammals, thus preserving the type notwithstanding the Sauroid tendency in the scapular arch.

The *Pelvic Arch* and *Appendages.*—The *Pelvis* resembles that of the Marsupialia in the presence of the "marsupial" bones, which are however relatively larger and stronger in this order; and it resembles that of Reptiles in the length of time during which the three components of each os innominatum remain distinct. In the great development of the *Ileopectineal spine** of Ornithorhyncus compare Tortoise. In the *perforated Acetabulum* of Echidna compare Aves. The *Femur* is short, broad, and flattened; the *Fibula* is longer than the *Tibia* by the extent of a process which rises upward some way above the point of articulation with tibia, and like the olecranon is greatly expanded at its termination. Both Monotremata have a sesamoid bone placed at the interspace between the astragalus and the naviculare; and a second supernumerary bone articulated to the posterior part of the astragalus which supports the perforated spur, characteristic of the male sex.

§ See note on p. 56.

* In the Macropidæ this is also strongly developed.

DIGESTIVE SYSTEM—General.

The *Digestive Apparatus* in this Class is of varied complexity; but in almost all Orders are to be found a Mouth, Tongue, Salivary Glands, Teeth, Œsophagus, Stomach, Small Intestine, Liver, Pancreas, Spleen, and Large Intestine (the commencement of which is commonly marked by a Cæcum). Of these we shall treat in order.

The *Mouth* is almost always *terminal,* and *bounded by fleshy lips;* these form the main characteristic of the Mammalian Mouth, inasmuch as the act of sucking is characteristic of all young Mammalia, and this cannot be performed without definite lips. The *Lips* admit of various modifications, especially in the Quadrupeds, in which they are the main agents in the prehension of food: the upper lip is generally entire, but frequently marked with a median groove. The *Gape* of the mouth is of variable width, but is rarely so small as to admit only of the mere protrusion of the tongue. In most Mammalia the *Side Walls* of the mouth are dilateable and contractile, and Cheek Pouches are sometimes found (chiefly in species of Insect-diet): the Buccal membrane is commonly smooth; though sometimes beset with hard tubercles. The *Palate* is usually more or less ridged transversely, and the Velum palati* scooped out into a semilunar form, the *Uvula*† being absent in nearly all except the highest members the class. *Tonsils* are generally met with; and are largest in the rapacious and carnivorous species.

* *Soft* palate.

† A conical process prolonged from the middle of the pendulous margin of the Soft-palate in Man.

The *Tongue* attains in this class its full development as an Organ of Taste (*q.v.*): it is commonly divided into a free, gustatory, and sensitive part; but in the matter of freedom we meet with every gradation, from almost fixity to high extensibility. It subserves several different mechanical offices, being instrumental in the prehension, distribution, and sometimes even trituration of food.

Nearly all Mammalia have *Salivary Glands*; the ratio of their development varying directly with the nature of the food and the time spent on mastication: they are larger in those species which are Herbivorous than in those which are Carnivorous, and are more highly developed in proportion as the food is masticated for a longer period. The Glands commonly found pouring their secretion into the mouth are, the Parotid, Submaxillary, and Sublingual: besides these there are numerous Mucous Crypts* on the inside of the mouth and on the Palate, *e.g.*, Labial, Buccal, Zygomatic, Molar, and Palatine. The *Parotid*, situated generally between the Ear (*παρά*, near; *οὖς*, *ὠτός*, the ear) and the lower Jaw, behind the Masseter, penetrated by the Facial nerve, and whose duct (ductus Stenonianus) opens between the Jaw and the Buccal membrane in the neighbourhood of the upper Molar teeth, is relatively the largest in Mammals that *masticate* most, and feed chiefly on vegetables and *fruit*. The *Submaxillary*, normally situated between or alongside the rami of the lower Jaw, and whose duct (ductus Whartonianus) opens inside the lower dental arch close to the frænum of the Tongue, upon the margin of the Sublingual, is largest in those species that need the greatest amount of *viscid lubricating* secretion, and have an *animal* or *mixed diet*. The *Sublingual* situated by the side of the frænum of the Tongue pours forth a *viscid* secretion; it is not always present. The *Subsidiary Glands* are most developed in the Herbivorous Mammals in relation

* Termed collectively the *Subsidiary* Glands.

to the movements and mastication of their coarse vegetable food: their secretion is more *mucous* than lubricating or solvent. In short, the Parotid secretes the more fluid Saliva, which moistens in ordinary mastication the whole mass; the other glands secrete the slimy lubricating Saliva. The *Quantity of Saliva* secreted by the Parotid (*e.g.* in Horse) is in direct ratio to the dryness of the food and the difficulty experienced in its mechanical division: while that secreted by the Sublingual and Submaxillary flows in nearly equal abundance, whether Mastication be exerted on dry or moist forms of food.

The *Teeth* present remarkable differences in Structure, Replacement, Form, and Number, which stand in close relation with the whole economy, mode of life, and form of the species; but generally agree in limits of Situation and mode of Fixation. *Structure.*—In some genera *Horny Laminæ* take the place of teeth*; but, as a rule, hard unvascular *Dentine*, and *Cement*, exist in every Mammalian tooth; and *Enamel*, though not constantly present, is generally found. In the newly formed tooth the Cement is always the outermost substance, and between it and the Dentine the Enamel is interposed. The thickness of the coating of Cement in the adult varies with the diet, being thin in those species that partake of flesh or mixed diet, and thicker in those that feed on herbs. According to the different arrangement of the Enamel, three well marked *patterns of teeth* are distinguishable: (i.) d. *Simplices* s. obducti, in which the Enamel forms an entire and uniform cap to the dentinal pulp; (ii.) d. *Complicati* s. semicompositi, in which the Enamel followed by the Cement is inflected or penetrates into the Dentine and forms folds; (iii.) d. *Lamellosi* s. compositi, in which the folds of Enamel penetrate so far towards the root of the tooth as to divide it into

* Balæna. Ornithorhyncus.

distinct laminæ, each of which is at the same time separated and held together by the softer Cement which external to the Enamel follows its every fold. *Replacement.*—In almost every species the teeth are formed in *Alveoli*; but in some, the tooth when completed and worn down is not replaced; while in others, two distinct sets are developed which have been termed Permanent, and Temporary (Deciduous, or Milk) teeth respectively. The *Permanent* and *Deciduous* teeth are both formed simultaneously side by side from independent portions of the primitive dental groove; but the one destined for early functional activity proceeds rapidly in its development, while the other makes little progress until the time approaches when it is called upon to take the place, by vertical displacement, of the more precocious locum tenens*. The process of *Replacement is never repeated more than once* in any Mammal. Those species which generate only a single set of teeth are termed *Monophydonts*† (μόνος, once; φυω, I generate; ὀδους, tooth); those which generate two sets are termed *Diphyodonts* (δις, twice, &c.). Some species, however, seem to occupy an intermediate position in this respect, in that the successional process is confined to a single tooth on each side of the jaw‡. *Number.*—A few genera and species are *devoid of teeth*§. The so called *'typical' number of teeth* in this Class is forty-four||, but the number varies excessively; from one fully developed¶, to one hundred and ninety**. The 'typical' number of true Molars in the Placental Mammalia with two sets of teeth (*i.e.*, Diphyodonts) is three. The more purely carnivorous the species and the more it feeds upon living prey, the less numerous are the Molars. *Situation.*—*True teeth implanted in Sockets are confined to the Maxillary, Premaxillary*††,

* Flower.

† Cete, In-Enamellata, Monotremata. ‡ Infra. Marsupialia.

§ Myrmecophaga, Manis. Echidna. || Cf. Insectivora. Artiodactyla.

¶ Cf. infra. *Situation.* ** Cf. In-Enamellata. †† or *Inter*-maxillary.

and Mandibular or lower maxillary bones, and *form a single row* in each: they may be a-symmetrical, either as comparing one jaw with the other, or even one side of the same jaw with the other, though this is rare. When there is but one fully developed tooth* it is *never median.* The teeth *never* all *make an unbroken series* in any existing † Mammal save in man. Those teeth which are implanted in the Premaxillary bones and in the corresponding part of the lower jaw are called '*Incisors*,' whatever their shape or size: the tooth in the Maxillary bone which is situated at, or near to the suture with the Premaxillary is the '*Canine*,' as is also that tooth in the lower jaw which, in opposing it, passes in front of its crown, when the mouth is closed: posteriorly to these are situated, in the *Deciduous* dentition, the '*Milk Molars*'; and in the *Permanent* dentition, the *Premolars* (succeeding the Milk Molars) and the true *Molars* (without predecessors). ***Fixation.*** —*In no Mammal* does *anchylosis of the tooth with the jaw* constitute a normal mode of attachment. Each tooth has its particular Socket, to which it firmly adheres, by the close coadaptation of the apposed surfaces, and by the firm adhesion of the alveolar periosteum to the organised Cement which invests the fang or fangs. The complicated form of Socket which results from the development of two or more Fangs is peculiar to species of the class Mammalia. ***Form.***— Three parts are generally recognisable in a Mammalian tooth; the *Fang*‡, or Root, the inserted part; the *Crown*, or exposed part; and the *Neck*, or constriction which divides the Fang from the Crown. It is peculiar to this Class to have teeth with two or more Fangs wherewith to be implanted in Sockets; but Fangs are not always present: for there are

* Narwhal.

† In Anoplotherium, Nesodon, and Dichodon the teeth are said to have formed an unbroken series.

‡ The term *Fang* is properly given only to the implanted part of a tooth of restricted growth, which fang gradually tapers to its extremity.

some teeth which grow perpetually during the life of the owner; such teeth require their base to be kept widely excavated for the *Persistent pulp*,* and have therefore neither Neck nor Fang. In most Mammalia particular teeth have special forms for special uses: Incisors for cutting and scraping; Canines for holding and tearing; and Molars for grinding; but the *Deciduous and Permanent* representatives of each series *differ slightly inter se*: thus the Permanent Incisors and Canines† differ from their Deciduous predecessors in size; and the Permanent Premolars which succeed the Deciduous Molars have generally less complex Crowns than their predecessors. The Molars, properly so called (*i.e.*, those posterior teeth which have no deciduous predecessors), are usually the most complex in their form. Similarity of form is characteristic of the teeth of Monophyodonts. The *modifications of the crown of the Molar teeth* are those that are most intimately *related to the kind of food* of the species possessing them. Thus in the purely *flesh-eating* Mammalia the principal Molars are simple, *trenchant*, and play upon each other like scissor blades: in those species that *break bones* the Molars have *conical* Crowns: in the *mixed feeding* species, the working surface becomes broader and more *tuberculated;* and in the *insectivorous* species it is *bristled* with sharp points: in those that *eat shell-fish* the Molars are small and *obtuse;* and in the *partly herbivorous* species, the flat grinding surface of the teeth is complicated by *folds and ridges* of Enamel entering the substance of the tooth. When teeth are *in excessive number* they are generally small, equal, or sub-equal, and of a simple conical form.

The cavity which is bounded anteriorly by the soft Palate, and precedes the commencement of the alimentary canal (or gullet), *viz.*, the *Pharynx*, is generally funnel-shaped,

* Cf. Rodentia. Proboscidia. In-Enamellata.

† Cf. Supra. *Situation*.

wider above than below, formed by a continuation of the integument of the nasal cavity and of the mouth, and extending from the base of the skull: it has seven openings leading into it: at its upper part, in front and above the level of the soft Palate, are the two posterior Nares, and, on each side, the apertures of the Eustachian tubes; below the soft palate is the isthmus of the Fauces, opening into the Mouth: posterior to the root of the tongue is the opening into the Larynx protected by the Epiglottis: lastly, the contracted part of the funnel forms the Œsophageal opening.

The *Œsophagus* is nearly cylindrical; it is generally long and narrow, and forms the narrowest part of the Intestinal Canal: after passing into the Abdomen through a slit in the Diaphragm it usually expands at once to form the Stomach: its muscular coat consists of two layers; the external fibres having a longitudinal direction; the internal fibres surrounding the canal generally in a circular or spiral manner: its mucous membrane and the innermost covering of Epithelium form, usually, longitudinal folds which become more conspicuous on contraction of the muscular coat: it is rarely provided at its termination with valvular spiral folds: but as a rule passes to the stomach without any valve. The Œsophagus of Mammalia is *never wholly destitute of a Sheath of striated muscular fibre* (as is that of Sauropsida)*.

The *Abdomen*, as a definite and circumscribed visceral chamber, is peculiar to the present class; the Heart and other thoracic viscera being shut out by the complete transverse septum or 'Diaphragm' from the major part of the trunk cavity.

The *Stomach* presents remarkable diversities. In the greater number of Mammalia it is *simple* as in Man, though frequently with the pyloric portion reverted. Sometimes the Cardiac portion is divided from the Pyloric by a *constric-*

* Gulliver.

tion, visible externally; sometimes such division existing internally is scarcely visible outside; in either case the Pyloric end may be itself further sub-divided. Again, though very rarely, there is found a sort of *glandular Proventriculus,* separated by a constriction from the wide muscular part of the Stomach. Further, the Stomach may be *complex,* made up of many compartments, and this even in some flesh-eating species. Lastly, the Stomach is sometimes found *intestini-form.* The *size of the Cardiac* portion of the Stomach is mainly dependent on the nature of the food; it attains its maximum in the herbivorous Ruminantia (in which the first three stomachs are apparently divisions of the 'Fundus ventriculi' of Man), and is much reduced in most flesh feeders; this correlation is further demonstrated by the fact that the *fourth* Stomach of the Ruminant is the largest as long as the animal sucks. In Mammalia a capacious and complex *alimentary canal, as a whole,* is almost invariably correlated with a restricted vegetable diet; though the extent to which, and the mode by which the complexity is attained is variable: either a highly developed and concentrated glandular apparatus may be added to the Stomach, as in Castor, Myoxus, and Phascolomys; or the Stomach itself may be amplified, subdivided, or sacculated, as in the Ruminantia, and Herbivorous Marsupialia; or both these complexities may be combined, as in the existing Sirenia and the Bradypodidæ; or, lastly, if a simple condition of the Stomach is retained, the compensation of complexity may be attained by the presence of a large sacculated colon and cæcum. The Pylorus is occasionally defended by a valve. Accumulation and detention of vegetable food in the stomach occasions frequently 'bezoar' concretions.

The relative length of the Intestinal canal varies, being, in general, longest in the vegetable feeders, and short in the flesh

feeders: but, taking all Orders together, it is usually more extended in Mammalia than in other Vertebrata.

The presence of a Cæcum and ileocæcal valve generally marks off the Intestinal Canal into the two main divisions, called from the difference of their calibre in Man, 'Small' and 'Large' intestine, names which lose their significance in many lower Orders: of these two, the *Small Intestine* is usually the longer, and beset on the inside with *Villi* of various size, or with elongated longitudinal folds in the place of Villi. The 'ductus communis choledochus' conveys the Bile into the Duodenal segment, and, prior to opening into the Intestine, is generally joined by the Pancreatic duct; and runs for a space between the muscular and mucous coats of the Intestine, where a dilatation of the duct is sometimes found. The *Cæcum* may be small and conical, large, or sacculated, and occasionally, though very rarely, double. The presence and size of the Cæcum varies directly with the nature of the food, being either absent or small in flesh feeders, and highly developed in vegetable feeders. Further, it would appear, from the Rodentia, that the Cæcum is large, when food is but slightly nutritious and little varied; while it is small when nutritious food is readily obtainable. A *Vermiform appendix* to the Cæcum is most exceptional.

The clusters of Peyer's glands are as a rule considerably developed.

The *Mesentery* is usually of greater extent than in Man: a large and small *Omentum* are regularly present; but the great Omentum, which is said to be peculiar to Mammalia, co-existing with the diaphragm, does not always overlie the same parts. Large Omental processes with accumulated fat are never continued from the urinary bladder, and rarely from the pelvic or other regions of the abdominal walls, as they are in most Reptilia. Small processes from the serous coat

of the large intestine are developed in many Ungulata, and are called 'appendices epiploicæ' in the human subject.

At the end of the *Rectum* glands are frequently situated, which secrete a fatty and strongly odorous fluid. The termination of the Intestinal Canal is usually distinct from the sexual aperture.

The *Liver* is situated ventrally* to the Diaphragm, chiefly on the right side as in Man: it is usually divided distinctly into two principal lobes: in many species it is tri-lobed, in others multi-lobular: the greater the number of its divisions, the more does it extend to the left side. The right third of the gland is in most Quadrupeds sub-divided into two or more lobules, the left third more commonly remains single. The Liver is generally divided into a greater number of lobes in the flesh feeders than in the vegetable feeders: in other words, it is most subdivided in those species whose food presents the greater amount of hydro-carbonates for elimination, and hence it is least subdivided in the purely herbivorous Ungulates. It is small and little divided in Mammals with divided or compound stomachs. The lobulus spigelii is constant in its position behind the small Omentum. A *Gall Bladder* is usually present, though frequently wanting: it is wanting in a greater number of species of this class than of any other; in the flesh feeders the gall bladder is always present; and generally also in insect feeders: it is usually single. When the gall bladder is present, a 'Cystic,' 'Hepatic,' and 'Common †' *Bile Duct* exist, as in Man. The number of branches which unite to form the hepatic duct vary; thus, in Man, two emerge at the portal fissure; but, in more divided livers, the liberated ducts are more numerous. The *Portal Vein* in Mammals is formed by (1) the Coronary vein of the stomach, (2) the superior Mesenteric vein, which returns the

* *i.e.* in the Abdominal cavity. *Vide supra*, Abdomen.

† 'Ductus Communis Choledochus.'

blood not only from the Spleen, but also from the Pancreas, the Duodenum, the greater part of the Stomach and Omentum, the descending Colon, and part of the Rectum.

The *Pancreas* lies a little dorsad* of the stomach, and between the Spleen and the Duodenum: it is commonly divided into two lobes, though occasionally it is tri-lobed: it may have one or two excretory ducts; when the duct is single it usually joins that from the Liver before reaching the Intestine; if a second duct is present it enters the Duodenum by itself.

DIGESTIVE SYSTEM.—Special.

1.—*Mouth.*

—*Not always terminal.*

A rostral production sometimes makes the oral opening sub-terminal, or inferior (*e.g.* Sorex, Elephas, Tapirus). Ornithorhyncus is provided with a mouth nearly resembling the flat and sensitive bill of the Aves Chenomorphæ.

2.—*Lips.*

—*Not always present.*

Cete. In the Delphinidæ they are barely represented.

Monotremata. They are manifest at the suckling period only.

—*Modified for prehension or uprooting.*

In animals that feed on succulent and luxuriant herbage, the Lips are capacious, strong, and pendulous, for the purpose of grasping and detaching their food.

Proboscidia. The under lip alone is free: the upper lip blends with the nose, and is with it produced into an elongated cone, moveable in every direction, and terminated by a thumb-like appendage, endowed with exquisite sensibility, and capable of picking up the smallest objects. (*cf.* Organs of Sense, Nose.)

Perissodactyla. The Multungulate Tapir has a similar arrangement to that found in the Elephant.

* *i.e.* between the Stomach and the Vertebral Column.

Artiodactyla. The mouth of the Hog tribe has the upper lip and nose modified to form the 'snout.'

—*Do not always form entire segments of an ellipse.*

Cheiroptera. In Nycteris the two converging ridges of the lower lip enclose a triangular prominence of the upper lip.

Rodentia. In some Rodentia the upper lip is partially cleft.

Proboscidia. In Elephas the under lip is produced into a pointed form.

Artiodactyla. In the Camelidæ a mid-fissure divides the upper lip.

Marsupialia. The upper lip is partially cleft in the Macropidæ.

3.—*Gape of the Mouth.*

Cheiroptera. Those species that feed on insects have a very wide gape.

Sectorialia. The mouth is characterised by the width of its gape.

In-Enamellata. In the Edentula (Myrmecophagidæ) the long and tubular mouth seems to serve mainly as a sheath for the slender tongue when retracted.

Monotremata. The mouth of Echidna is long and tubular, as in the Ant-Eater, and terminates by a small orifice.

4.—*Cheek Pouches.*

Quadrumana. Cheek Pouches are never found in the highest Apes. But in the lower Catarrhina, and in these alone of this Order, they are found.

Rodentia. In Cricetus (Hamster) the wide orifice of the pouch is just within the commissure of the short lips: the bag itself extends along the side of the head to the neck. In Saccostomus it reaches back as far as beneath the ear.

Sectorialia. Cheek pouches have not been found in any species.

Marsupialia. A few species have Cheek Pouches. In Koala they are wide and shallow. In Didelphys Yapock they are large.

Monotremata. Ornithorhyncus has an oblong Cheek Pouch, in which it may stow away fresh water Insects, Crustacea, &c.

5.—*Buccal Membrane.*

Artiodactyla. In the Ruminantia the cavity of the mouth is lined with retroverted papillæ.

In-Enamellata. In Myrmecophaga the Buccal membrane rises in

two ridges, just anterior to the angle of the jaw, which become very callous, and seem to occupy the place of teeth: in Myrmecophaga Didactyla they form horny plates.

6.—*Palate.*

In *Bimana* and the higher *Quadrumana* the Palate is smooth and unridged.

Rodentia. The roof of the mouth is commonly beset posteriorly with two rows of hard oblique ridges, and in Capromys three hard tubercles are found anteriorly. In Capybara the constriction of the soft Palate reduces the communication between the mouth and pharynx to a small aperture.

Artiodactyla. In the Camelidæ a broad pendulous flap hangs down from the fore part of the soft Palate, and usually rests upon the dorsum of the tongue, though it is sometimes greatly enlarged. Its surface shows the pores of innumerable mucous crypts: the secretion these provide aids in keeping the surface of the pharynx and root of the tongue moist when water is scarce. The back of the mouth appears to be as completely closed in the Giraffe as in Capybara.

Monotremata. In Ornithorhyncus the soft Palate is thick, broad, and divided posteriorly into three fimbriated lobes. In Echidna the Palate is armed with six or seven transverse rows of sharp short retroverted spines.

7.—*Uvula.*

Bimana. The Uvula is almost characteristic of the Order.

Quadrumana. In the Catarrhina a short Uvula is apparent. In the Platyrrhina the fauces are but slightly divided. In the Lemuridæ there is sometimes found* a median longitudinal fold from the back of the soft palate close to the margin, but this never projects so far as to divide the fauces into two arches.

In-Enamellata. In Dasypus 9-cinctus the soft palate is thickened in the middle, like a rudimental Uvula.

8.—*Tonsils.*

Rodentia. The Tonsils are perhaps the most feebly developed in this Order.

* *e.g.* in Aye Aye.

Sectorialia. The Tonsils are largest in the Digitigrada, especially in Leo and some other Felidæ, in which each tonsil forms a sac: they are very small in the Semi-plantigrada, but large in the Plantigrada.

9.—*Tongue.*

(For Tongue as Organ of Taste, *cf.* Special Sense Organs.)

—*Protrusibility.*

Rodentia. The Rodentia have the least power of protruding and moving the tongue, in the whole Mammalian class.

In the *Proboscidia*, *Cete*, and *Sirenia*, the Tongue is but slightly moveable.

In the *In-Enamellata* the tongue of Myrmecophaga affords an example of one the most protrusible of all in this Class.

—*Subserving prehension.*

Cheiroptera. The tip of the Tongue is furnished in many species with long pencillate papillæ at its apex, useful for probing night-blowing flowers for minute Insects (*e.g.* in Monophyllus). In Desmodus (Vampire) the terminal papillæ resemble wart-like elevations, so arranged as to form a circular suctorial disk when required.

Sectorialia. The Felidæ have horny spinules on the fore part of the dorsum of the Tongue, which form a powerful rasp, to clean bones.

The act of lapping may be noticed as an instance in point.

Artiodactyla. The Tongue of Giraffa affords an instance of one long and prehensile.

In-Enamellata. In the Edentula the most obvious office of the Tongue is that of prehension: the soft viscous apex, presenting an adhesive surface, is insinuated into the Ant-hills, whence the Termites are withdrawn, entangled in the viscid saliva that covers it.

—*Subserving distribution of food in the mouth.*

This is a common function of the Tongue, but is especially noticeable in *Ornithorhyncus*, where the posterior or intermolar portion of the Tongue is provided anteriorly with two projecting, short, conical, horny bodies, which can impede the passage of unmasticated food to the pharynx, and direct it on each side into the cheek pouches.

—*Subserving trituration of food.*

In-Enamellata. In the Ant-Eaters the Tongue is used to crush the termites against the callous ridges (*supra* 5) on each side of the mouth.

Monotremata. The dorsum of the Tongue in Echidna is broad, flat, callous, and beset with hard papillæ (representing in these lowly organised Mammals the lingual teeth of Fishes), between which and the palatal spines (*supra* 6) insects are crushed. The conical processes on the Tongue of Ornithorhyncus may also subserve the same purpose.

10.—*Salivary Glands.*

—*Ratio of their development.*

Cheiroptera. In the Insect-eating Bats the Maxillary exceeds the Parotid gland in size: but in the fruit-eating Pteropines the Parotids are the larger glands.

Rodentia. In the Omnivorous Rats with ferine tendencies, the Submaxillaries are in excess: in most other Rodents, which subsist mainly or exclusively on vegetable products, the Parotids are the largest.

Marsupialia. The proportions of the Parotid and Submaxillary differ according to the nature of the food, as in Rodentia.

—The *Parotid Gland.*

Rodentia. In Castor (Beaver) the Parotids are enormous, extending from before the ears, forward and downward, to meet the Submaxillaries (which are about one-twentieth their size), the whole forming a sort of glandular collar. A similar development is found in the Leporidæ. In Cricetus (Hamster) the Parotids are applied to the back of the cheek pouches.

Sectorialia. In the Seal tribe the Parotid is either very small or wanting. In the Dog it is comparatively small; relatively larger in the Cat; and more so in the Bear tribe.

Proboscidia. The salivary glands are all largely developed.

Perissodactyla. In the Horse the Parotid forms a considerable mass, extending from its normal position behind the Masseter upwards to the Ear Conch, the base of which it embraces, and downwards to the Larynx, where it meets its fellow.

Artiodactyla. The Parotids are large in all Ruminantia.

Cete. In the Piscivorous Cete, which bolt their food like Fishes, the *Parotids are absent.*

Sirenia. The Parotids are large (the species of this Order browze on fuci).

In-Enamellata. In the Great Ant-Eater the Parotid gland is

small in proportion to the animal; but the duct, about eleven inches in length and half a line in diameter, is perhaps the longest duct, in proportion to the size of the animal, in the animal kingdom.*

Marsupialia. In the Great Kangaroo the Parotid is very large, extending from below the auditory meatus three or four inches down the neck: in the Potoroos it reaches as far as the clavicle: but in both is separated from the Sub-Maxillary.

Monotremata. In Ornithorhyncus the Parotid is divided into flat lobes, thinly applied to the fundus of the cheek pouch (*cf.* Cricetus, Rodentia).

—The *Sub-Maxillary Gland.*

Sectorialia. This Gland in the Dog is large and globose.

Perissodactyla. These Glands are about one fourth of the size of the Parotids, by which they are covered.

Cete bolt their food, and have no such Glands; except the Balænidæ, in which they are present in a diffused form.

In-Enamellata. Those which have long tongues (*e.g.* Myrmecophaga, Dasypus,) have a *bladder superadded* to this Gland, both for storing up the quantity of secretion needed in a sudden excess of outflow in lubricating the tongue, and also for increasing the tenacity of the secretion so poured out by the absorption of some of the serous part of the saliva during its detention therein.

Monotremata. In the Echidna this Gland is of unusual dimensions; it extends from the meatus auditorius along the neck, and upon the anterior part of the thorax. The duct subdivides and dilates when it reaches the interspace of the lower jaw; serving the same end as the pyriform bladder of some In-Enamellata (*vide supra*). This modification of 'Wharton's duct' appears to be unique.*

11.—The *Teeth.*

Bimana.—Structure. All the teeth are 'simplices' s. obducti: the coronal Cement is of extreme tenuity, seldom so thick as to show a bone cell. The Dentine is 'unvascular' (*i e.* the tubules are not large enough to admit capillary vessels with red blood corpuscles).— *Replacement.* The 'Deciduous' series consists of

$$i\,\frac{2\,.\,2}{2\,.\,2},\; c\,\frac{1\,.\,1}{1\,.\,1},\; m\,\frac{2\,.\,2}{2\,.\,2} = 20.$$

* Owen.

The Permanent series consists of

$$i\,\frac{2\,.\,2}{2\,.\,2},\ c\,\frac{1\,.\,1}{1\,.\,1},\ p\,m\,\frac{2\,.\,2}{2\,.\,2},\ m\,\frac{3\,.\,3}{3\,.\,3} = 32.$$

The outer Incisor and the two anterior Premolars of the 'typical' series being suppressed.—*Number.* They are the same in number and in kind as in the Catarrhine Quadrumana.—*Situation.* They stand in one continuous unbroken row, describing a regular parabolic curve, and seldom have any, even the slightest, interval or 'diastema' between the lateral Incisor and Canine on either side of the upper jaw. The Incisors are vertical, or nearly vertical, in position. —*Form.* They are of equal length or depth of crown, and show no sexual distinctions. The Incisors are characterised by their true wedge-like form, equality of size, and small size relatively to the other teeth and to the entire skull. Both upper and lower Premolars are bicuspid and implanted by a *single* conical fang (*or*, two conate, in upper jaw): the outer curve of the premolar part of the dental series being greater than the inner one, the outer cusp of each Premolar is the larger. The third Molar (dens sapientiæ) is the smallest in both jaws. In the Upper Jaw the first and second true Molars support four trihedral cusps which present strong sigmoid curves, and are generally implanted by three diverging fangs; the first Molar is considerably worn before the completion of the Molar series by the acquisition of the Dens Sapientiæ. In the Lower Jaw the crowns of the true Molars are quinque-cuspid, and these teeth are implanted by two fangs with median grooves.

Quadrumana.—Number. The Incisors are commonly $\frac{2\,.\,2}{2\,.\,2}$ and the Molars 'typical' $\left(\frac{3\,.\,3}{3\,.\,3}\right)$.—*Situation.* The Incisors generally incline forward from the vertical line*. A break or diastema* in the dental series is generally found for the reception of the crowns of the Canines when the mouth is closed. The Canines and Premolars generally form nearly a straight* line with the Molars.—*Form.* The lower Incisors are broad and thick. The Premolars, which are bicuspid, have the outer cusp of the first and the inner* cusp of the second the largest; alternating thus by reason of the teeth being situated in a straight line. The Molars are broad and tuberculated, and the four cusps rise distinct and independently of each other.

Catarrhina.—Structure. All the teeth are simplices; the coronal cement is thin.—*Number.* Have the same number and kind of teeth as Bimana: $p\,m\,\frac{2\,.\,2}{2\,.\,2}$.

* Cf. Bimana, *supra.*

—*Form.* Each Incisor has a prominent posterior basal ridge: the middle pair are generally larger than the lateral Incisors; and all four bear a larger proportion both to the entire skull and to the rest of the teeth than in Bimana. The Canines of the Baboons are deeply grooved in front, like the poison fangs of some Snakes. The Premolars as well as the Molars are severally implanted by one internal and two external fangs.

Platyrrhina.—Number. Have four more teeth in the Molar series than the Catarrhina, *viz.* *p m* $\frac{3 \cdot 3}{3 \cdot 3}$. The 'Marmosets,' however, have but *two true Molars* on each side of both jaws, their dental formula being *i* $\frac{2 \cdot 2}{2 \cdot 2}$; *c* $\frac{1 \cdot 1}{1 \cdot 1}$; *m* $\frac{2 \cdot 2}{2 \cdot 2}$. —*Form.* Molars have blunt tubercles.

Lemuridæ.—Number. Incisors are commonly $\frac{3 \cdot 3}{3 \cdot 3}$, and Premolars $\frac{3 \cdot 3}{3 \cdot 3}$ (Lichanotus), or $\frac{2 \cdot 2}{2 \cdot 2}$ in number.—*Situation.* In the upper jaw of Otoclinus and Lemur the small Incisors are vertical.—*Form.* The Incisors are generally modified somewhat toward the Rodent and Marsupial type, the inferior ones are long and narrow. The Molars have sharp tubercles. The dentition of Cheiromys (Aye Aye) is modified in analogical conformity with the Rodent type, to which it makes a very close approximation, in the absence of Canines, and, the wide vacancy between the single pair of scalpriform Incisors and the short series of Molars: it may be distinguished from that of Rodentia in that *a.* the crowns of the upper incisors project obliquely forward, and do not extend vertically downward (Rod.); *b.* the lower Incisors are more curved, and *c.* all the Incisors are entirely invested with Enamel, which is however thicker upon the front than upon the back part of the tooth.

Insectivora. The dental system in this Order is remarkable for the many varieties and even anomalies which it presents; almost the only characteristic predicable of it being the presence of sharp points or cusps upon the crowns of the molar teeth.—*Structure.* The teeth consist of a basis of hard Dentine, with a thick coronal investment of Enamel (especially in Soricidæ), and the usual outer covering of Cement: around the fangs the Cement usually assumes the character of true bone, traversed by medullary canals. —*Replacement.* The Deciduous teeth of the Talpidæ and Soricidæ are uterine, *i.e.*, are developed and disappear before birth.—*Number.* Two species in this Order have the 'typical' number of teeth, *viz.*, Talpa and Gymnura, each having the dental formula

$$i\,\frac{3 \cdot 3}{3 \cdot 3};\ c\,\frac{1 \cdot 1}{1 \cdot 1};\ p\,m\,\frac{4 \cdot 4}{4 \cdot 4};\ m\,\frac{3 \cdot 3}{3 \cdot 3} = 44.$$

Chrysochlore approaches, in the number of its Molar teeth, the remarkable condition which a solitary genus of existing Marsupials (Myrmecobius) also presents; judging from the form of the teeth, it has at least $\frac{6 \cdot 6}{5 \cdot 5}$ true Molars. In Rhynchocyon (African Shrew)

the upper Incisors are absent; the premaxillary bones terminating in a trenchant edentulous border, as in the true Ruminant.—*Situation.* In Galeopithecus the two anterior Incisors of the upper jaw are separated by a wide interspace. In Chrysochlore the true Molars are separated from each other by vacant intervals, as in many Reptiles.—*Fixation.* In the Shrew the roots of the lower *Incisors become anchylosed to the jaw-bone,* a Reptilian character offered by the Soricidæ alone in the Mammalian Class.—*Form.* The crowns of the first two Incisors of Galeopithecus present the form of a comb, and are in this respect unique in the Class Mammalia: the second upper Incisor presents the peculiarity of an insertion by two fangs. In Amphisorex and Rhynchocyon the lower Incisors are notched, or bilobed. In Chrysochlore the three anterior teeth in the upper jaw, situated in the premaxillary bone, and therefore 'Incisors,' are laniariform. The crowns of the Molar teeth are generally bristled with sharp points or cusps, and are always broader in the upper than in the lower jaw. In Chrysochlore the crowns of the upper true Molars assume the form of thin plates, narrowed from before backward, with two notches on their working edge, and a longitudinal groove along the outer and thicker margin; the lower true Molars are of unusual length.

Cheiroptera.—Replacement. The Deciduous teeth make their appearance above the gum before birth, as in Soricidæ, but they attain a more completely developed state, and are retained till a short time after birth.—*Number.* Incisors may be present as $\frac{2\,.\,2}{3\,.\,3}$, or $\frac{1\,.\,1}{1\,.\,1}$, or absent. Canines are always present in both jaws. The Molar series never exceeds $\frac{6\,.\,6}{6\,.\,6}$, and in the Vampire is reduced to $\frac{2\,.\,2}{3\,.\,3}$.—*Form.* Incisors, when present, are always very small, and, in the upper jaw, commonly unequal: in Chilonycteris the mid-incisors above and the outer ones below have the crown notched: in Phyllostoma the mid-pair above are large and laniariform: in Desmodus they are two in number in the upper jaw, with large, compressed, curved, and sharp-pointed crowns. The Canines are always of the normal form. The Molar series are bristled with sharp points in the great bulk of the Cheiroptera. In Desmodus (Vampire) the true Molars with the bristled crowns are absent, and the Molar series have simple compressed conical

crowns. In the great frugivorous species (Pteropidæ) the Molars have broad flat crowns.

Rodentia. The Rodentia are characterised by two large and long curved Incisors in each jaw, separated by a wide interval from the Molars; for no Rodent is possessed of Canines.—*Structure.* The Incisors consist of a body of compact Dentine, more dense anteriorly than posteriorly, with a plate of Enamel laid generally upon the anterior surface of the tooth alone (the Enamel consisting of two layers, of which the external is denser than the internal); and a general investment of Cement, which is very thin upon the Enamel. In Leporidæ the Enamel is traceable to the back of the tooth. The Molars have always a coating of Enamel, the vertical folds of which generally penetrate the crown of the tooth: these folds have a general tendency to a transverse direction. In those Rodentia that have *rootless Molars* the folds of Enamel extend inwards for the entire length of the sides of the tooth, which may be thus distinguished from the rootless Molar of the In-Enamellata. The Chinchillidæ, and Capybara, afford good examples of the Dentes 'compositi,' with plates of Enamel, followed by Cement, parallel. In all Rodentia, vascular Dentine forms but a small constituent of the Molar tooth; the pulp, after forming a certain thickness of tubular Dentine, becomes converted into Osteodentine.—*Replacement.** The first or anterior tooth of the Molar series, whether the number be 2-2, 3-3, or 4-4, is a Premolar (*i.e.*, has displaced a deciduous predecessor in a vertical direction).—*Number.* The Incisors (= Dentes Scalprarii), are never more than two in number in either jaw, except in the Leporidæ, which have two pair, placed one pair (the smaller) behind the other, in the upper jaw. The Molars are not numerous in any Rodent.—*Situation.* The Molar teeth are obliquely planted, the series on each side converging anteriorly in both jaws.—*Form.* The upper pair of Incisors describe a larger segment of a small circle, the lower ones a smaller segment of a larger circle: they are of unlimited growth (*i.e.* with '*persistent*' *pulps*), and therefore without 'neck' or 'fang:' they have a sharp anterior margin, from which they slope obliquely back, like a chisel, and are thence named dentes *scalprarii:* when an opposing incisor is lost, following the curve prescribed to their growth by the form of their socket, their points often return against some part of the head, completing the circle.

* *Cf.* Marsupialia, *id. infra.*

The Molars are sometimes rootless; sometimes have short roots, tardily developed; and sometimes ordinary roots soon acquired. These differences in the mode of implantation relate to the differences of diet. Those Rodentia which subsist on mixed food, and which have a tendency to carnivorous habits, or subsist on nutritious vegetable substance (*e.g.* oily kernels) have their Molars, 'simplices,' *rooted*, and with shallow crowns: *e.g.* most Hystricidæ, Muridæ, and Sciuridæ. Those Rodentia which feed exclusively on vegetable substances, especially on the less nutritious kinds, have their Molars 'complicati,' with incomplete and *lately developed roots*, and a limited growth of crown; *e.g.* Castoridæ. Those Rodentia which are strictly herbivorous have their Molars 'lamellosi,' and *rootless; e.g.* the Leporidæ and most Cavidæ. The rootless and perpetually growing Molars are always more or less curved.

Sectorialia. Throughout the Order the Incisors are small, and, except in a few Seals, $\frac{3 \cdot 3}{3 \cdot 3}$ in number; the Canines are long, largely developed, $\frac{1 \cdot 1}{1 \cdot 1}$ in number, the lower passing anteriorly to the upper, as usual, when the mouth is closed. The Molars follow the general rule, both as to number and form, in accordance with the variation of diet; but, in all, the last Premolar ($p\,m$ 4) of the upper jaw works upon the anterior true Molar (m 1) of the lower jaw, and in the strictly flesh-feeding genera, scissor fashion; each of these two teeth was denominated by F. Cuvier 'dent carnassière,' which has been rendered 'dens *sectorius*,' the 'sectorial' or scissor tooth; hence the name here given to this Order. A tubercle is generally present at the inner side of the base of the anterior part of the crown of the 'sectorial' tooth; the development of the tubercle bears an inverse relation to the carnivorous propensity of the species. In general the crowns of the teeth of the upper and lower jaws interlock.

Digitigrada. The Incisors have broad and thick crowns, shaped as a trefoil in Hyænidæ; indented by a transverse cleft in Felidæ; or with two notches in Canidæ; and are situated in a transverse row; the exterior Incisors above being larger than the four middle ones. Canines are slightly curved, and have a fang as long or longer (Felidæ) than the crown. In all Digitigrada there is a *pit internal to the last Premolar of the upper jaw*, which receives the crown of the first true Molar of the lower jaw. Both Felidæ and Hyænidæ have but a single minute tubercular true Molar on each side of the upper jaw; and the inferior Molar series are all of the 'sectorial' form, and so set as to shut within the upper,

like shears: but the Hyænidæ may be distinguished by *a.* the shape of the crowns of the Incisors, *b.* the relative strength of Molars and Canines, *c.* the additional Premolar on each side in both jaws; and *d.* the basal ridge which girds the conical (for breaking bones) Crown of the second and third Premolar in both jaws, and defends the subjacent gum. The Viverridæ and Canidæ have both $p\ m\ \frac{4\ .\ 4}{4\ .\ 4}$ and $m \frac{2\ .\ 2}{2\ .\ 2}$ in the upper jaw; but in the former, the Canines are more feeble, and have smoother crowns; the Molar series are less trenchant and more tubercular; and the inferior true Molars fewer in number, *viz.*, $m\ \frac{2\ .\ 2}{2\ .\ 2}$, than in the latter. The Canidæ are distinguished by the form of the Incisors; by having the first lower true Molar anteriorly sectorial, and posteriorly tuberculate; and the true Molars below $m\ \frac{3\ .\ 3}{3\ .\ 3}$.

Semi-Plantigrada. The Mustelidæ have great development of the inner tubercle of the Sectorial tooth: the Molar series nearly approaches that of the Hyænidæ.

Plantigrada. All approximate more or less to the dentition of the families of the Ursidæ: the dental formula is essentially the same, both in number and kind of teeth, in the genus Ursus, as in the genus Canis. But the chief characteristics of the dentition of the Bears are, the development, in the lower jaw, of the true Molar teeth to their typical number in the placental Mammalia; their general manifestation, in both jaws, of a tuberculate grinding surface: and the reduction in size of the Premolars, of which, the last in the upper jaw ($p\ m$ 4), becomes more directly and completely opposed to its homotype in the lower jaw than is the case in those species more nearly allied to the typical family of the Order, *viz.* the Felidæ. The true Molar in Meles deserves special notice, on account of its enormous size as compared with its homotype in the two preceding Sub-orders. In the Ursidæ m 2 is generally considerably developed.

Pinnigrada. The Incisive formula never exceeds $\frac{3\ .\ 3}{2\ .\ 2}$; and in the adult Walrus is reduced to zero in the lower jaw, and one pair in the upper jaw. All possess powerful Canines in both jaws, except Walrus, in which they are absent in the lower jaw; here, however, as if by way of compensation, the upper Canines are of enormous size, tusk-like, with 'persistent pulps,' and compelled to pass outside the lower jaw when the mouth is shut. The Molar series usually consists of $p\ m\ \frac{4\ .\ 4}{4\ .\ 4}$; $m\ \frac{1\ .\ 1}{1\ .\ 1}$, a second true Molar being rarely (*e.g.* Otaria) present. In the Phocidæ the fang or fangs of all the teeth are usually remarkable for their thickness, which commonly surpasses the long diameter of the crown. There is no special modification of the crown of any tooth by which it can merit the name of a 'sectorial:' and the co-adaptation of the crowns of the upper and lower teeth is completely alternate, each tooth in the lower series being anterior to its fellow in the upper series.

Proboscidia. Incisors are wanting in the lower jaw, but project

as long tusks in the upper jaw, one in each premaxillary bone. The Molars are large and complex: of these there are never more than two in place or in use on each side at any given time.—*Structure.* The Incisors, here called tusks, have 'persistent pulps,' and consist of ivory, *i.e.* a modification of dentine, with exceedingly small dentinal tubes, arranged in almost angular gyrations, and which shows, in section, striæ, proceeding in the arc of a circle from the centre to the circumference in opposite directions, and forming by their decussations curvilinear lozenges; the ivory is lowly vascular. The Molars afford striking examples of dentes lamellosi*; the growth of each plate begins at the summit, consequently they remain as separate denticles until their bases become contiguous and blend together. The number of plates in the first Molar is four, and each succeeding tooth has on the average four more plates than the one immediately preceding it.—*Replacement.* The Molar teeth succeed each other from behind, moving in the arc of a circle.—*Number.* The total number of teeth developed appears to be $i\,\frac{2\,.\,2}{0\,.\,0}$; $m\,\frac{6\,.\,6}{6\,.\,6}$.

Perissodactyla. The Incisors and Canines are near together, and a long diastema intervenes between them and the Molar series. The crown of from one to three of the hinder Premolars is as complex as those of the Molars. The outer side of the Upper Molars is generally impressed by two wide longitudinal channels.

The Incisor teeth of the Equidæ are distinguishable from those of the Ruminants by their greater curvature; and from those of all other animals by the fold of Enamel which penetrates the body of the crown from its broad flat summit, like the inverted finger of a glove, followed externally, as usual, by the cement, constituting the 'mark'† of veterinary authors. The Canines are large in the Horse; rudimentary in the Mare. The lower Canine, though situated as in the Ruminants, close to the outer Incisor, is distinguished by its cuspidate form. The Molars of the Equidæ may be distinguished from the complex teeth of other Herbivora corresponding with them in size by the great length of the tooth before it divides into fangs. In the Tapiridæ, the existence of a transverse without an antero-posterior valley results in the division of the crowns of the Molar series into a pair of transverse ridges.

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* *Cf.* Capybara (Rodentia), *supra.*

† The cavity in the *lower* Incisors, or 'mark,' is usually obliterated, in the first or mid-Incisors at the sixth year, in the second Incisors at the seventh year, and in the third or outer Incisors at the eighth year.

Hyracoidea. The Incisors are large, and, to a certain extent, Rodent-shaped: the Canines are wanting: the Molar series is of the 'typical' number. The first Premolar differs from the rest only by a graduated inferiority of size, which in the last Premolar, *p m* 4, ceases to be a distinction between it and the true Molars. The pattern of the upper Molars is unsymmetrical.

Dental formula: $i\,\frac{1\,.\,1}{1\,.\,1}$; $c\,\frac{0\,.\,0}{0\,.\,0}$; $p\,m\,\frac{4\,.\,4}{4\,.\,4}$; $m\,\frac{3\,.\,3}{3\,.\,3} = 34$.

Artiodactyla. The crowns of the Premolars are smaller and less complex than those of the true Molars, usually representing half of such a crown. The true Molars are constant, $m\,\frac{3\,.\,3}{3\,.\,3}$; the Premolars are subject to variety.

Omnivora.—Structure. The Canines generally have Enamel only on the anterior convex surface. The tusks of the Hippopotamus exhibit the maximum density in their component tissues: the compact dentine differs from true ivory by showing in transverse section simple concentric, instead of curvilinear decussating lines. The last true Molar of Phacochærus is perhaps the most peculiar and complex tooth in the whole class of Mammalia: the surface of the crown presents three series of enamel islands; in the direction of the long axis of the grinding surface, blended into a coherent crown by abundant cement. —*Number.* Sus. Scrofa has the typical dental formula.—*Form.* Excessive development of Canines characterises all Omnivora: in Hippopotamus the Incisors are affected in the same way; the two median inferior incisive tusks being cylindrical, and of great size and length. The Molars of Hippopotamus are characterised by the trefoil shape of the two divisions of the crown, one valley bisecting the middle of the crown transversely, with two shorter indents parallel to it, one on either side. In the Suidæ the upper Incisors decrease in size from the first (*i* 1) to the third (*i* 3), receding from each other in the same degree: and the teeth of the Molar series progressively increase in size from the first to the last. In Babyrussa the upper Canines are bent abruptly upwards, and curve backwards, penetrating the upper lip.

Ruminantia. The development of horns bears an inverse relationship to the development of the anterior teeth. The typical Ruminantia (Cavicornua) never have upper Incisors (their place is taken by a callous pad), and very rarely upper Canines: their inferior Canines are procumbent, and are similar to, and form part of the same series with the Incisors: most of their deciduous Molars resemble in form the true Molars, which are separated by a wide interval from the Canines, and have their grinding surface marked by two double crescents, the convexity of which is turned inward in the upper and outward in the lower jaw. The last true Molar of the lower jaw in all Ruminantia is characterised by the addition of a third posterior lobe: and in all Ruminantia the outer contour of the entire Molar series is slightly zigzag, the anterior and outer angle of one tooth, projecting beyond the posterior and outer angle of the next in

advance. The dentition of the Solidicornua follows that of the Cavicornua pretty closely, except that the males sometimes have Canine teeth in the upper jaw (esp. Cervus Muntjak). The Carenticornua presents considerable anomalies; though, agreeably to the rule as to horns above noted, all have Canines in the upper jaw (especially developed in Moschus moschiferus). The Camelidæ have a pair of laniariform Incisors in the upper jaw; the inferior Canines distinct from the Incisors in their laniariform development, and more erect in position than in the ordinary Ruminantia; and, lastly, the anterior Premolar laniariform in both jaws.

Cete. All are Monophyodont, none truly edentulous: for the Balenidæ manifest in their fœtal state a true dental system, in the shape of a series of minute calcified denticles in an open groove extending along the alveolar border of both the upper and the lower jaws. In no Cete, except the common Dolphin, are teeth implanted in the Intermaxillaries. The primitive seat of the development of the tooth matrix is maintained longer in the Cete than in other Mammalia; and, except in the rudimental tusk of the Narwhal, is at no period enclosed in a bony cell: in this respect the Cete offer an interesting analogy to true Fishes. The teeth in the Cete are all of one kind, and usually of a conical shape.

The Whales proper (Balænidæ) have the fœtal dentition of the upper jaw succeeded by horny substitutes in the form of plates, terminated by a fringe, situated on either side of the upper jaw, behind each other: the plane of each plate is at right angles with the axis of the skull, and depends vertically from the palatal surface of the maxillary, and of the anterior part of the palatine bones. The lower jaw of the Whale that has passed its fœtal existence has neither teeth nor baleen. The plates are shaped like an obtuse-angled triangle, the fringed side being that subtending the obtuse angle; one side enclosing the angle forms the outer margin of the baleen plate; the other is hollow and has this cavity filled with baleen pulp, which is formed of parallel descending tubes passing into bristly fibres at the inferior margin of the horny lamina, of which the external or cortical substance of each plate consists; and is imbedded in a compact sub-elastic substance, attached to the palate. The Sperm Whale (Physeter) has teeth in both jaws, but they are visible only in the lower jaw, in which they are situated in a wide and moderately deep groove in the dense semi-ligamentous gum. The first formed extremity of the tooth in the young Physeter (Cachalot) is capped with enamel, which however gets worn off when the tooth is fully developed. In Phocæna Orca (Grampus) the laniariform teeth are as large in proportion to the length of the jaws, as in the Crocodile, and are separated by intervals, so that the upper and lower teeth interlock. In the Narwhal two rudimental teeth are enclosed in a horizontal alveolus at the junction of the intermaxillary with the maxillary; one of which, the left, is in the male further developed into a tusk nine feet long, marked exteriorly by spiral ridges; and with a pulp cavity throughout its entire length internally.

In the common Dolphin the number of teeth amounts to 190; the maximum number in the Class Mammalia.

Sirenia, are Diphyodonts*, and have teeth of different kinds, Incisors and Molars. In Halicore (Dugong) the superior Incisors alone project in the male, and in the female neither upper nor lower Incisors are visible. The Molars have flattened or ridged crowns adapted for vegetable food. Those of Halicore consist of a large body of dentine, a small central part of osteo-dentine, and a thick external investment of Cement; *Enamel is absent.* In Manatus Molars are present in both jaws. In Halicore abortive teeth alone are found in the deflected portion of the lower jaw.

In-Enamellata. This Order includes two genera, which are devoid of teeth, Myrmecophaga and Manis; the rest are possessed of those organs. The Bradypodidæ generate only one set; they are, therefore, Monophyodont. The Dasypodidæ probably all generate two sets, and are therefore Diphyodont. The teeth are very rarely implanted in the intermaxillary bones. *No true enamel is present on any tooth* (hence the name here given to this Order). The teeth are of uninterrupted growth, and are concomitantly implanted by a simple, undivided, and generally deeply excavated base.

The teeth of the Dasypodidæ (Armadillos) are harder than those of other species of Inenamellata: those of Orycteropus are continued solid, and of the same dimensions, to the bottom of the socket; where they terminate in a truncate undivided base, and may be looked upon as an aggregate of small denticles. D. Sexcinctus has the anterior tooth, which is shaped like the succeeding Molar, implanted in the Intermaxillary bone. Of the eight teeth constantly found in each side of the mouth of the nine-banded Armadillo, both in Maxilla and Mandible, all except the most posterior in each set are preceded by well-developed functional milk teeth, which closely resemble the permanent teeth in form, and nearly equal them in size, and are not shed until the animal has almost attained its full development†. An example of excessive number of teeth occurs in this family in the Priodont Armadillo, which has ninety-eight teeth. In the Bradypodidæ the teeth seldom exceed $\frac{5 \cdot 5}{4 \cdot 4}$ in number; of these the anterior one on each side is generally much prolonged.

Marsupialia. Replacement. The animals of this Order present a peculiar condition of dental succession, uniform throughout the Order, and distinct from that of all other Mammalia. This peculi-

* Cf. infra. Marsupialia, *Replacement.*

† Flower. *Journal of Anat. and Phys.* 1869.

arity may be thus briefly expressed. *The teeth of Marsupialia do not vertically displace and succeed other teeth, with the exception of a single tooth on each side of each jaw.* The tooth in which a vertical succession takes place is always the corresponding or homologous tooth, being the hindermost of the Premolar series, which is preceded by a tooth having the characters more or less strongly expressed of a true Molar. If you divide the Mammalia in regard to the succession of teeth into Monophyodonts and Diphyodonts, the Marsupials occupy an intermediate position, presenting as it were a rudimentary Diphyodont condition, the successional process being confined to a single tooth on each side of the jaw; to which, however, analogous examples may be met with in the Placental series in the Dugong and Elephant, in which the successional process is limited to the Incisor teeth; and in those members of the Rodentia which have but four teeth in the Molar series, *i.e.*, three true Molars and one premolar (*e.g.* Beaver, Porcupine), in which the latter is, exactly as in the Marsupialia, the only tooth which succeeds a deciduous tooth*.—*Number.* Incisors are present in all the species, but are variable in number; in some genera (*e.g.* Peramelidæ and Didelphidæ) of the flesh-eaters, exceeding that of the Mammalian type in the upper jaw ($i\ \frac{5\ .\ 5}{}$). Canines are present in all the flesh-eaters, but are not constant in the plant-eating genera, being absent in the Phascolomydæ and Macropidæ (except in upper jaw of Hypsiprimnus, and the fœtal Macropus; in the latter they are never functional), and but feebly represented in the Phalangistidæ (absent in lower jaw of Phascolarctos). The typical number of teeth in the Molar series is seven on each side of both jaws. Those posterior teeth of either side of each jaw which have no deciduous predecessors are as a general rule, *four* in number, instead of three, as in most Placental Mammalia; but in Myrmecobiidæ the number of true ($m\ \frac{6\ .\ 6}{6\ .\ 6}$) and false Molars is eighteen in each jaw, exceeding that of any other known existing Marsupial (*cf.* supra; Insectivora; *Chrysoclore*); and Petaurus pymæus is said to have only three true Molars on either side of each jaw. The dental formula of the Phascolomydæ is the same both in number and kind to that of Rodentia. The dental system of the Dasyuridæ corresponds generally with that of the Sectorialia; it differs in having the Incisors in greater num-

* Flower. *Phil. Trans.* 1867.

ber, and the Molars of a more uniform and simple structure. *Situation.* In the Dasyuridæ the points of the lower Canines are received in hollows of the intermaxillary palatal plate, and do not project, as in the Sectorialia, beyond the margins of the maxillary bones. In the Myrmecobiidæ the inferior Molars are directed obliquely inwards, and the whole dental series describes a slight sigmoid curve.—*Form.* All the Incisors in the Myrmecobiidæ are slightly compressed and *pointed.* In Phascolomydæ and Macropidæ they have persistent pulps. The anterior tooth of the Molar series in Hypsiprininus has a peculiar trenchant form, indented especially on the outer side, and in young teeth, by many small vertical grooves. In the Phascolomydæ the false and true Molars have persistent pulps, and are consequently devoid of true fangs, in which respect the Wombat differs from all other Marsupials, and resembles the dentigerous In-Enamellata and herbivorous Rodentia. The Premolars of the Macropidæ are distinguished by being compressed, and narrower in front than behind, having two cusps behind and one in front. In the omnivorous Peramelidæ the Molars (originally quinque-cuspidate) early assume a smooth oblique grinding surface. In the Myrmecobiidæ the Molars are multicuspidate.

Monotremata. In Echidna teeth are wanting. In Ornithorhynchus two horny plates, consisting of a series of close-set vertical hollow tubes, and situated on each side of each jaw, eight in all, serve for teeth: the anterior pair, above and below, are narrow and somewhat trenchant, the posterior pair are subquadrate and slightly tuberculate, each tubercle being separately developed, and becoming confluent with its fellows in the course of growth. (For lingual teeth, see above, p. 72.)

12.—The *Pharynx.*

Perissodactyla. In the Horse the Pharynx is capacious and communicates with a pair of large sacculi at the ends of the Eustachian tubes.

Artiodactyla. In Giraffa the back part of the mouth terminates by a transverse slit, through which projects the broad upper margin of the Epiglottis, which is folded upon itself.

In-Enamellata. In Dasypus (Q. Cinctus) the Epiglottis projects through the arch of the Soft Palate.

13.—The *Œsophagus.*

— is *short* and *wide* in all *Sectorialia.*

The Œsophagus is of *small area* in the largest species of *Cete*.

— extends beyond the diaphragm in Cercopithecus, the small Platyrrhines, and Cheiromys ($\frac{1}{3}$ inch), of the *Quadrumana;* in most *Insectivora, Rodentia,* and *Hyracoidea;* in the Didelphidæ and Macropidæ (M. major. 5 in.) of the *Marsupialia;* and in the *Monotrematous* Ornithorhyncus.

— has in Leo (? all Felidæ) (*Sectorialia*) a third layer of longitudinal fibres applied to the inner side of the circular ones at the terminal part of the Œsophagus.

— has in Leo (? all Felidæ) (on account of the special arrangement of the muscular fibres) the lining membrane puckered up into numerous narrow alternating transverse rugæ. A similar structure is present in Didelphys Virginiana (Marsupialia).

— in Æquus (*Perissodactyla*) presents a more or less large sickle-shaped fold, developed close to the Cardiac orifice of the stomach, which prevents the return of food, so that the Horse cannot vomit.

— has *a sheath of striated muscular fibre*. Several different Orders, or Families of Mammalia have a sheath of striated muscular fibre extending all along the Œsophagus, to or even on the Cardia, as may be well seen in Ruminants, Rodents, Bears, and many others: it may, however, stop short of the Cardiac end of the Œsophagus, *e.g.* in Man, Quadrumana, Felidæ, the Horse, and many others.*

14.—The *Stomach*.

(*a*) — is SIMPLE in

Bimana, in which the Cardiac pouch is relatively small, and the Œsophagus enters near the Cardiac end, thus admitting of an extensive lesser curvature.

In most *Quadrumana, e.g.* the tail-less Apes, the Lemuridæ (in which last the Cardiac portion is large), and Cheiromys, in which the Stomach is subglobular.

In nearly all *Insectivora*, the Cardiac and Pyloric orifices being approximate.

In the Insect-eating *Cheiroptera*.

In the *Sectorialia*, where the Cardia and Pylorus are generally wide apart; the '*blind* sac' is of small extent, and the Pyloric end is bent abruptly and closely upon the middle of the stomach. The

* Gulliver.

epithelial lining of the gullet terminates abruptly at the Cardiac orifice.

In the *Proboscidia,* where however the stomach is longer than usual, with the Cardiac sac much produced and conical.

In most *Perissodactyla.*

In the *Hyracoidea,* in which two-thirds of the cavity are lined with a thick white epithelium; and the stomach is bent upon itself where this lining ceases.

In nearly all Dasypodidæ, and some Myrmecophagidæ of the *In-Enamellate* Order, where the muscular coat is more or less thin at the Cardiac end, and thick, with a tendinous spot externally, at the Pyloric end: especially in Manis, in which the structure is made the more gizzard-like by its thick papillose cuticular lining.

In all *Marsupialia,* whether flesh-, insect-, or leaf-eaters, except the Macropidæ.

And in the *Monotremata;* in Ornithorhyncus the stomach is membranous, and chiefly remarkable for the close approximation of the Cardiac and Pyloric orifices: in Echidna the tunics of the stomach are thin to near the Pylorus, where the muscular coat assumes something of the gizzard character.

(*b*) — is *simple, but with glandular patches,* in

The insectivorous *Bats,* in which the gastric membrane at the Pyloric end of the stomach assumes a glandular character.

The Castoridæ among the *Rodentia,* where the gastric glands are situated near the Cardiac orifice, arranged in longitudinal rows.

And the Phascolomydæ of the *Marsupialia,* where the conglomerate gastric gland is of a flattened ovate form, near the Cardiac orifice, and with its excretory orifices scattered.

(*c*) — is CONSTRICTED *into two or three portions, e.g.*

In the Phyllostomidæ and Pteropidæ of the *Cheiroptera,* of which in Desmodus the Cardiac portion is produced into a long intestiniform reservoir, the rest of the stomach being long and narrow, bent upon itself.

In most *Rodentia,* and is especially noticeable in Cricetus externally and Meriones internally. In Mus Rattus, the œsophageal epithelium is usually continued upon the inner surface of the Cardiac compartment, which is constricted from the middle portion, and that again from the 'blind sac' at the other end of the stomach; in Arvicola amphibius, and Lemming, the Cardiac and middle compartments form

one elongated cavity, separated by constriction from the Pyloric portion, which again throws off a small sacculus above; in Lepus, there is a well-marked tendinous patch on the Pyloric compartment.

In the *Perissodactyle* Horse, the thick cuticular lining of the Cardiac Cul-de-sac terminates abruptly by a prominent indented edge, separating it from the Pyloric half with its villous surface.

In the Omnivorous *Arthodactyla.*

In the *In-Enamellate* Ant Eater, the spherical stomach has a subglobular appendage, as it seems, intervening between the main cavity and the intestine: on both the anterior and posterior surfaces of the stomach is a sheet of tendon: the Pyloric division is remarkable for the thickness of its muscular tunic, and the density of its epithelial lining, which convert it into a veritable gizzard.

(*d*) — *has a quasi-glandular* PROVENTRICULUS *attached.*

A long glandular proventriculus, separated as in Birds by a constriction from the wide muscular stomach, is found in Myoxus Avellanarius (Red Dormouse).

(*e*) — is COMPLEX.

In the *Artiodactyla* the Stomach is generally made up of four distinct cavities, respectively called 1. Rumen, or Ingluvies; 2. Reticulum, or Honeycomb; 3. Psalterium, Maniplies, or Omasus; 4. Abomasus. The Rumen is the largest of the four cavities, and the reservoir for the food previous to re-mastication: the inner surface is covered with papillæ (cuticular villi), except in the Camelidæ, where large cells below and at the sides are found for the retention of water; it secretes an alkaline fluid. The Reticulum, situated directly below the entrance of the œsophagus, always receives the water. The cells vary in depth in different Families, but generally are directly correlated with the nature of the food, being very shallow when (*e.g.* Giraffa) the food takes the shape of juicy leaves and buds. A passage leads from the œsophagus to the third cavity, bounded by two low parallel ridges. The Maniplies is occupied by deep parallel crescentic folds, like the leaves of a book; in passing through this the food is deprived (by squeezing) of superfluous fluid: in the Camelidæ and most Moschidæ these longitudinal lamellæ are wanting. The Abomasus has the usual structure of the true digestive stomach; here the food is penetrated by acid gastric juice; this is therefore the seat of the true digestion. The Pylorus is protected by a valvular protuberance, placed above it, just within

the Stomach. The food is first swallowed only half masticated; the coarse bolus opens the lips of the groove, and falls into the Rumen; after maceration there, portions of the mass are transmitted into the Reticulum, and from thence into the demi-canal to be moulded into the form of pellets, which are carried up to the mouth by an anti-peristaltic action of the muscular coat of the Œsophagus: remastication renders the food softer, so that when it is again swallowed it passes through the groove (the walls of which are stimulated to contract) into the Maniplies, and then to the Abomasus.

In the *Cete* the Stomach is divided into several cavities: the first is a continuation of, and similar to the Œsophagus; its commencement is indicated by the orifice, surrounded by large irregular projections, leading into the second stomach, beyond which it dilates into a heart-shaped cavity; the second stomach is round, and leads by an oblique orifice into the third, which is likewise round, but small, and not visible externally; the fourth cavity is long and narrow, and pursues a serpentine course, almost like an intestine. The digestive process goes on in, or is assisted by the fluids in each and all of the cavities. This complex Stomach, being found even in the predaceous Phocæna orca (Grampus), affords an example of special development to meet special need; here, the need of extracting all the nutriment available, to maintain animal heat in a system in constant contact with a heat-absorbing medium.

It is singular, when this is considered, to find in the vegetable-feeding *Sirenia* a *less* complex Stomach than in the carnivorous Cete; in the Sirenia the Stomach assumes the constricted type, but has two appended sacculi opening on the pyloric side of the constriction, and a special spiral gland in the conical pouch that projects from the extremity of the cardiac portion: the Œsophagus enters the cardia in a valvular manner.

Among the *In-Enamellata*, Cholæpus (Two-toed Sloth) has a complex Stomach: the cardiac compartment is divided into a left and right portion, of which the left terminates below in a short cæcal appendage: between the right-cardiac and the pyloric portion a second cavity intervenes: the third, or pyloric cavity, being quite distinct, and separated by a constriction from the rest of the Stomach.

— *is Intestini-form, e.g.*—

Quadrumana. In *Semnopithecus Entellus*, where the left, or cardiac half forms a large cavity, many times constricted, while the right or pyloric portion is long, narrow, and intestini-form, and

sacculated along the line of the greater curvature, by means of a pair of strong muscular bands, like the human Colon.

Marsupialia. In *Macropus* (Kangaroo) the sacculated Stomach resembles the human colon, both in its longitudinal extent, structure, and disposition in the abdomen; three narrow longitudinal bands of muscular fibres extend the whole length, except near the Pylorus; the cardiac extremity is bifid, or subclavate.

15.—The *Small Intestine.*

— *Dilatation of the Duodenum.*

Rodentia. The Intestinal Canal usually begins by a well-marked dilatation. In Coypu this dilatation is so large that it projects towards the Œsophagus, like a Cæcum: the whole Duodenum is more continuously and loosely suspended than in most higher Mammals.

Perissodactyla. Commencing from the Pylorus, the Duodenum is considerably dilated, but its diameter soon contracts.

Artiodactyla. The Duodenum is always dilated at its commencement; it there forms a distinct pouch in the Camel.

Cete. The Duodenum always commences by so considerable a dilatation that it has been sometimes reckoned among the divisions of the complex Stomach.

In-Enamellata. In Dasypus the Duodenum is dilated at its commencement.

Marsupialia. In Phascolarctos the Duodenum commences with a small pyriform sacculus, nearly an inch in breadth, but soon contracts to a diameter of five lines, which is the general calibre of the small Intestines.

— *Mucous Lining, Villi, Folds, Glands,* &c.

Bimana. The surface of the Mucous Membrane is extended by transverse folds, or valvulæ conniventes, in the Jejunum and Ileum; where also are to be found, situated opposite the line of attachment of the mesentery, numerous patches of 'agminate follicles.'

Insectivora. As a rule, the Intestinal Canal is uniform in diameter, and devoid of Cæcum. The lining membrane of the intestine of Talpa is disposed along part of the canal in close-set longitudinal folds; but is remarkable for its smoothness, and the absence of visible Villi.

Proboscidia. The termination of the Ileum projects as a conical valve into the Cæcum. The mucous coat of the Jejunum is thrown into small irregular folds, both transverse and longitudinal.

Perissodactyla. In Rhinoceros the lining membrane of the Duodenum is, at the commencement, puckered up into irregular rugæ; flattened triangular processes begin to make their appearance about six inches from the pylorus; in the Jejunum three or four of these processes are often supported on a common base; as they approach the Ileum they begin to lose breadth and gain in length, until they assume the appearance, near the end of the Ileum, of vermiform processes, like tags of worsted, from two-thirds of an inch to one inch in length.

Hyracoidea. The agminate follicles are lodged in fossæ of the mucous membrane. The small Intestines present internally a series of twelve small pouches, which make no projection externally, being situated wholly beneath the muscular coat.

Artiodactyla. In many species of Ruminantia, especially Giraffa, the same arrangement of the Agminate Follicles is observed as in Hyracoidea.

In-Enamellata. In Myrmecophaga the inner surface of the Duodenum and Jejunum is smooth, presenting no villi to the naked eye. In Dasypus peba there is a well-marked zone of racemose glands beyond the Pylorus. In Orycteropus the small Intestines are of unwonted length, about thirty-seven feet, and their lining membrane without folds, but beset with fine villi.

Marsupialia. In most species, even the most carnivorous, there is a zone of glands at the commencement of the Duodenum. In Phascolarctos the end of the Ileum protrudes for the extent of a quarter of an inch within the Cæcum.

Monotremata. The mucous coat of the Intestine of Ornithorhyncus contrasts with that of Echidna in the presence of numerous transverse and oblique folds, which are absent in the latter.

16.—The *Cæcum*

— *is absent* in

most *Insectivora,* except the Tupaias and some snouted Shrews;
all *Cheiroptera,* except Rhinopoma and Megaderma Spasma;
the *Myoxidæ* of the Rodentia, which hybernate, like the Bear;
the *Semiplantigrade* and *Plantigrade* Sectorialia;
and in the *Bradypodidæ* (Inenamellata).

— is *small and simple,* though occasionally bifid, in

Bimana, where it is short, wide, and sacculated;
the *Catarrhine* and *Platyrrhine* Quadrumana;

the *Muridæ*, *Sciuridæ*, and *Hystricidæ* of the Rodentia (*cf.* Teeth);

most *Digitigrade* and *Pinnigrade* Sectorialia, especially in the typical Felidæ, *e.g.* Leo [being longer in Hyæna than in Leo, and again longer in Canis than in Hyæna];

all *Artiodactyla;*

all *Sirenia* [that of Manatus being bifid];

the Entomophagous *Marsupialia,* and all Marsupials that have a sacculated Stomach;

and the Monotremata [that of Echidna being vermiform and glandular].

— is *long,* and *frequently sacculated* in

all *Lemuridæ,* or Strepsirrhine Quadrumana [in Cheiromys, and Stenops Javanicus, it contracts at its termination, and becomes glandular];

many *Rodentia* [in Bathyergus (Mole Rat) and Arctomys (Marmot) the inner membrane of the Cæcum is augmented by transverse or circular folds. In Coypu the Cæcum is puckered into sacculi by two muscular bands. In Capybara the enormous Cæcum occupies almost the whole of the posterior half of the abdomen. In most vegetarian Rodentia the Cæcum is long, especially so in the Leporidæ. Two oval patches are usually found on either side of the ileocæcal valve. In the Leporidæ the termination of the Cæcum is slender and glandular, like the vermiform appendage in Man];

the *Proboscidia,* in which the large Cæcum is sacculated on three longitudinal bands;

the *Perissodactyla* [in Equus Caballus the Cæcum is sacculated on four longitudinal bands; but in Rhinoceros on a single broad band on the anterior surface];

the *Balænoptera* (Cete); where the Cæcum, though simple, is of considerable length;

and in the *Carpophagous Marsupials* [the Phalangers having a Cæcum sometimes twice the length of the body; the Koala having a Cæcum three times the length of the body, with its inner secreting membrane further augmented by several nearly parallel plaits, continuing from the Colon three-quarters of the way towards the blind extremity].

— has a *Vermiform Appendix* in

Bimana;

the *Higher Catarrhine* Apes, *e.g.* Simia (Orang), and Hylobates (Gibbon);

and in *Phascolomys* (Wombat) of the Marsupials.

— is *double* in

the *Hyracoidea*, where there is, first, a sacculated Cæcum, whose length, from the orifice of the Ileum, is three inches, and circumference eight inches: and, secondly, two conical Cæca, proceeding from the dilated part of the Colon; each of these lower Cæca being an inch and a half in diameter at its base, and gradually contracting till it terminates in a glandular vermiform appendage, about half an inch long—;

and in the little *Two-toed Ant Eater*, and *Six-banded Armadillo*. In the last named, the large Intestine expands into a pair of short wide pouches, one on each side the insertion of the Ileum; the terminal orifice of the Ileum being a slit with tumid margins on the middle of the ridge, between the two Cæca.

17.—The *Large Intestine*.

Rodentia. In Arvicola (Water Vole) the Colon begins by a pair of large sacculi, but quickly contracts to the same calibre as the Ileum.

Artiodactyla. The Colon, in part of its course, is disposed in five spiral coils, like a screw, coming nearer the centre: these spiral turns form one of the characteristics of the Order.

In-Enamellata. In Bradypus (Sloth) the Colon is short and straight (Avian point).

Marsupialia. In Koala the inner surface of the large Intestines is extended by longitudinal valvulæ conniventes. In the Kangaroo the lining membrane is disposed in a very fine network.

Monotremata. Ornithorhyncus has no valvula coli; the first half of the Colon has longitudinal folds, the remainder a smooth inner surface.

18.—*Termination of Intestine*.

In-Enamellata. In the Bradypodidæ (Sloth) the anus in the female is not distinct from the generative outlet.

Marsupialia. In all Marsupialia two sebaceous follicles open into the termination of the rectum. The anus has its proper sphincter, but it is also surrounded, in common with the genital outlet, by a larger one. When the Penis is retracted, the fæcal, urinary and

genital canals all terminate within a common external outlet; so that in the literal sense the Marsupialia are monotrematous.

Monotremata. The rectum terminates at the anterior and dorsal part of the vestibular compartment of the Cloaca.

19.—The *Great Omentum*
— is small, and *does not cover the Intestines*
in *Proboscidia*, *Perissodactyla*, and *Sirenia.*

20.—The *Liver*
— is *simple*
in Bimana and Cete.
— is *Multifid,* to a greater or less degree in
most other Orders, the average being seven to eight lobes.

Rodentia. In Capromys each lobe is subdivided into almost innumerable angular lobules, which, though closely in contact, are quite detached from each other, being appended by their apices to the large branches of the vena portæ and hepatic arteries and veins. Each of the lobules is partially subdivided into still smaller ones, the whole structure approximating to a complete natural unravelling of this conglomerate gland to its component acini.

Ungulata. The Liver is least subdivided in the purely herbivorous Ungulates. The Perissodactyles have in general a larger and more subdivided Liver than the Artiodactyles, especially than the Ruminants, in all of which (R.) the Liver is confined to the right hypochondriac (υπο, under; χονδρος, cartilage, of ribs), and epigastric (επι on; γαστηρ the stomach) regions.

Marsupialia. The Liver is subdivided into many lobes in all; but especially in Koala, where the under surface is subdivided into thirty or forty lobules.

21.—The *Gall Bladder*
— is *absent* in
some *Cheiroptera, e.g.* Roussettes and Colugos;
some *Rodentia, e.g.* Mus, Cricetus (Hamster), and Helamys (Jerboa);
the *Proboscidia,* where however the hepatic duct is wide and very long, with a reticulate inner surface, and expands between the coats of the duodenum into an oval receptacle, irregularly divided into compartments;
all *Perissodactyla;*
some *Artiodactyla, e.g.* Camelidæ and Cervidæ;

all *Cete;*

and some *In-Enamellata.* [Bradypus *tri*dactylus has no gall bladder, though Bradypus *di*dactylus is possessed of one.]

— is *generally present*

in *all the other Orders;* and in most genera of the Cheiroptera, Rodentia, Artiodactyla, and In-Enamellata, with the exception of those noted above.

In the *Insectivora* it is for the most part of considerable size.

In the *Sectorialia* the inner surface of the gall bladder is minutely rugous and villous. In some Seals (*e.g.* Otaria) the ductus communis, after it is joined by the pancreatic duct, terminates in a dilated sacculus, within the duodenal coats.

In all *Cavicornua* (Artiodactyla) a gall bladder is present.

Of the *In-Enamellata,* the gall bladder is present in Bradypus didactylus, and all Dasypodidæ. In Orycteropus two separate gall bladders are found.

All *Marsupialia* and *Monotremata* have a gall bladder.

22.—The *Pancreas*

— is *branched,* or dendritic,

in several species of *Rodentia* and *Marsupialia.*

— has *a single duct, yet entering alone,*

in most *Rodentia,* where it enters the duodenum lower down than the bile-duct; and

in the *Monotrematous* Echidna, where it enters the duodenum, between the bile duct and the pylorus.

DUCTLESS, OR VASCULAR GLANDS.

1.—The *Spleen.*

The Spleen is always present, lies near the Stomach, and is commonly elongate and simple; but varies in form and size in the several Orders. Its development is directly correlated with that of the Pancreas. It is larger in the omnivorous and quasi-carnivorous Rodents, *e.g.* the Rats, than in the vegetarian species of the Order; it is also relatively larger in the Sectorialia than in the Ungulata.

Cete. In some Cete, *e.g.* Dolphin, the Spleen is remarkable for its sub-divisions.

Marsupialia. In most Marsupials the Spleen is bent, or bilobed.

2.—The *Thyroid.**

A Thyroid gland is generally present, situated in close relation to the Larynx, from the shield-shaped cartilage of which it has received its name. It usually consists of a pair of oblong lateral lobes, united by ligament.

3.—The *Thymus.*

This gland, which is formed towards the end of fœtal existance, and attains its greatest development during the period of lactation, is present in most Mammals at birth; the bulk of the gland lies behind the manubrium. It is distinguished from the Thyroid by its wide central cavity, and generally by its diminution in volume, or disappearance, early in life.

* θυρεος, a shield; ειδος, shape.

— *is persistent and large* in
all *diving animals; e.g.* Castor (Rodentia), Lutra and Phoca (Sectorialia), and Cete.

In the *Artiodactyla*, whether Ruminantia or Omnivora, the cervical portions of the Thymus are much developed, often extending to the mandibular angles.

4.—The *Supra-Renal* Capsules

are generally present, and always larger in the fœtal than in the adult animal: in lower Mammals they are not always in contact with the kidney, as they are in Man.

CIRCULATORY SYSTEM—GENERAL.

Absorbent Glands are much more numerous in Mammalia than in any other class; but are usually less numerous and more blended together in other orders than in Bimana; they present themselves on the lymphatics as well as on the lacteals; those on the lacteals ('mesenteric') sometimes cluster together into a single mass, named the Pancreas Asellii, at the root of the Mesentery. In the Mammalia alone of all Vertebrata are conglomerated or conglobate glands met with in the Mesentery. The Lacteals all discharge their contents into a *Receptaculum Chyli,* which is situated in the Lumbar region close to the spine, at which point the superficial lymphatics of the lower limbs communicate with them. One, or sometimes two, *Thoracic ducts* are continued anteriorly from the Receptaculum, and terminate at the junction of the Jugular and Subclavian Veins. When the Thoracic duct is single, it is always on the left; it often resembles rather a plexus of vessels than a single tube; branches proceeding from it and then re-uniting again; when there are two ducts, that on the right usually joins its fellow on the left prior to joining the venous system. In some of the lower Mammalia, however, a double thoracic duct is constant, one terminating on the left, the other on the right. No rhythmically pulsating sacs have been detected in the absorbent system of Mammalia. When a distinct wall can

be defined the Lymphatics of Mammalia are seen to be more numerous, minute, and highly organised than in the Lower Vertebrata; and to have their inner tunic folded to form *many* and *efficient valves* of the 'semi-lunar' type, commonly in pairs, rarely single.

The *Heart* consists of two auricles and two ventricles; the auriculo-ventricular chambers are usually quite distinct internally, but the division is seldom indicated externally. The venous and arterial parts of the vascular system have no communication beyond the heart, save at the peripheral capillaries. The Heart is invested by a pericardium. In the prone trunk of quadrupeds the pericardium adheres to the sternum, rarely to the diaphragm: from which in many Mammals it is more or less separated by a lobe of the lung. The form of the Heart is in general more rounded than in Man, the Apex is occasionally indented, and, most exceptionally, cleft. In Man the heart is placed obliquely; in lower Mammalia it is almost always placed more in a line with the axis of the body. The right auricle is less definitely divided into 'sinus' and 'auricle' proper than in Birds. The Foramen ovale, though generally closed in the adult, yet is sometimes found open some time after birth. The Eustachian valve is frequently wanting. The Precavals* ('descending cavæ') sometimes terminate in the auricle by distinct orifices. The right auriculo-ventricular valve resembles in structure the left, as being membranous and attached by tendinous threads to muscle; it rarely takes on the form of the single muscular valve of the Bird. Occasionally there is found as a normal formation, in the septum ventriculorum, below the origin of the aorta, a cruciform ossification called the bone of the heart. In most other particulars the Heart of other Mammals is the same as that of man.

* Owen.

The *Arteries.* In the Mammalian class the *Aorta* bends over the *left* bronchial tube: the chief primary branches of the *Arch* are given off at a little distance from its origin in variable order. But before forming this arch, it gives off close to its origin generally *two* ('coronary') arteries for the heart. The Aorta in some diving animals forms near to its exit from the heart a considerable dilation: and so also sometimes the Pulmonary artery. There are four principal varieties of form in which the vessels leave the arch. (1.) The *Human* type, *viz.*, a right arteria innominata, from which the right 'carotid' and right 'subclavian' are given off; the left 'carotid' and left 'subclavian' having each a separate origin. (2.) The *Bat* type, *viz.* two arteriæ innominatæ, each giving off the 'carotid' and 'subclavian' of its own side. (3.) The *Feline* type, *viz.* one arteria innominata giving off both 'carotids' and the right 'subclavian'; the left subclavian having a separate origin. (4.) The *Ruminant* type, in which the single arteria innominata gives off both carotids, and both subclavian arteries. The great *Arteries* of the posterior extremities are in most Mammals derived from a single * trunk on each side—the common iliac artery. *Retia Mirabilia* are found in various situations, and are constant characteristics of some genera: they have been found in the Skull, Orbit, and Nasal cavity, in the Thorax, round the Spinal cord, in the Arm, and in the Leg.

The *Veins.* The major part of the Venous system, after the vessels have gained, in returning from the capillary area, a conspicuous size, is furnished with valves † which occur usually in pairs. As a general rule valves are wanting in

* In Birds they are derived from two primary branches of the aorta, one corresponding with the external iliac and femoral, the other with the internal iliac and ischiadic arteries.

† No valves are met with in the veins of Reptiles and Fishes, and not many in those of Birds.

the superior and inferior cavæ, subclavian and iliac veins, and in the veins of the liver (both portal and hepatic), heart, lungs, kidneys, brain, and spinal cord. Many of the veins within the Cranium are included in spaces formed by the separation of the laminæ of the dura mater, and do not admit of being dilated beyond a certain size; these are termed 'sinuses.' In all Mammals may be found the 'superior longitudinal sinus,' united at the 'torcular Herophili'* with the lateral Sinuses. It is very rarely that the veins have an *outer* coat of circular fibres. In most higher Mammals there is one superior cava as in Man, but there are instances, by no means uncommon, of two anterior or descending venæ cavæ as in Birds. The posterior or inferior cava is commonly dilated in diving animals previous to entering the heart. The Portal circulation is limited in Mammalia to the Liver, the Kidney being supplied with arterial blood only. The veins of the Kidney are continued from the Renal artery, and communicate solely with the inferior cava. The Iliac veins combine to form the inferior cava in all Mammals, without conveying any part of their blood to the Kidneys. The external jugular veins are often very wide where they convey the blood from the brain sinuses as well as from the neck; in Man, the Quadrumana, and Sectorialia, the blood from the brain sinuses is conveyed by a separate channel, *viz.* the Internal jugular veins. A plexiform disposition of the veins is sometimes met with.

The *Blood* of Mammalia is hot and red: the blood corpuscle is, as a general rule, a circular† disc; and, whether circular or oval, instead of being swollen in the centre by a nuclear part, it is there thinner‡; the disc is consequently slightly biconcave. The average diameter of the human blood disc is $\frac{1}{3500}$: they

* In Man the sinuses which are contained in the several processes or folds of the dura mater converge to a common point, which corresponds with the occipital protuberance, and is called the *confluence of the sinuses*, or *torcular* (a wine-, or oil-press) *Herophili*.

† Camelidæ alone excepted. ‡ Non-nucleated.

are commonly somewhat smaller in other orders. In Mammalia the blood discs are most numerous, and most minute relatively to the bulk of the body, of all Vertebrata.

CIRCULATORY SYSTEM—Special.

1.—*Absorbent system.*

Quadrumana. The mesenteric glands are specially numerous.

Sectorialia. The mesenteric glands are aggregated in one mass, known to old anatomists as the Pancreas Asellii.

Ungulata. The mesenteric glands are numerous.

2.—The *Heart.*

—The *pericardium seldom reaches the diaphragm*

in any of the species composing the following orders, *viz.* :—*Insectivora, Cheiroptera, Rodentia, In-Enamellata, Marsupialia,* and *Monotremata.*

—The Heart shows *external signs of division*

in some *Rodentia.* The apex of the heart is sub-bifid in the Hare and Acouchi.

In some *Cete, e.g.* the Cachalots and Whales, the apex is rounded or rather flattened, and sometimes indented.

In all *Sirenia,* the outward division of the ventricles indicated in some Cete is carried to an extent very characteristic of the Order; but in Rhytina and Manatus the cleft is not quite so deep as in the Heart of Halicore.

—The *fossa ovalis.*

Marsupialia. There is no trace of a 'fossa ovalis' nor of an 'annulus ovalis'; and the absence of these structures, which are present in the heart of all the Placental Mammalia, relates to the very brief period during which the auricles intercommunicate in the Marsupials, and to the minute size, and in other respects incompletely developed state, at which the young Marsupial animal respires air by the Lungs, and has the mature condition of the pulmonary circulation established.

—The *foramen ovale.*

In the *Seals* (Sectorialia) and other animals that live in water the foramen ovale may remain open* for some time, but it is rare: in all Cete, and in the Dugong (Sirenia), the fossa ovalis is closed.

—*Each precaval* has a *separate orifice* into the auricle

in many *Insectivora, Cheiroptera, Rodentia, In-Enamellata, Marsupialia,* and *Monotremata.*

—*Eustachian Valve.*

Sectorialia. The Eustachian valve is wanting in most species.

Proboscidia. In the Elephant the Eustachian valve is large and spirally twisted.

Cete. The Eustachian valve is generally wanting.

—*Right Auriculo-Ventricular Valve.*

Monotremata. In the Ornithorhyncus the right 'tricuspid' valve consists of two membranous and two fleshy portions: the smallest of the latter is situated near the origin of the pulmonary artery, corresponds with the *lesser* fleshy valve in the heart of certain Birds, *e.g.* Pelican (Dysporo-morphæ: Desmognathæ), and is attached to the whole of the side of the first or adjoining membranous portion: the second fleshy portion answers to the *larger* muscular valve of the Pelican. The two edges of the *lower* half of the second fleshy portion of the valve in the Ornithorhyncus are free; but those of the *upper* half are attached to the two membranous portions of the 'tricuspid' valve; the margin of the membranous part of the valve is attached to the fixed wall of the ventricle by two small chordæ tendineæ; and *the structure of the valve thus offers an interesting transitional state between that of the Mammal and that of the Bird.*

—*Bone of the Heart.*

Artiodactyla. In most adult Ruminantia and some Omnivora (*e.g.* Hog), there is a bent bone at the base of the heart, on the septal side of the origin of the aorta, and imbedded in the tendinous circle which gives attachment to the muscular fibres of the ventricle.

3.—*Arterial System.*

—The *Coronary Artery* is said to be single† in the Elephant.

* Vander Hoeven, ii., 584.

† Camper.

—*Arch of Aorta.*

a. The *Human type* obtains in

Bimana; the higher *Catarrhine Quadrumana;* the *Claviculate Rodentia* (*e.g.* Muridæ, Castoridæ); most *Pinnigrade* Sectorialia; most *Balænidæ*, of the Cete; most *Sirenia;* the *Dasypodidæ* and *Bradypodidæ* of the In-Enamellata; a few broad-chested Marsupialia, *e.g.* *Koala* and *Wombat*; and the Monotrematous *Ornithorhyncus.*

b. The *Bat type* obtains in

the *Erinaceidæ* and *Talpidæ* of the Insectivora; most *Cheiroptera;* and some Delphinidæ (not Phocæna) of the Cete.

c. The *Feline type* obtains in

the Strepsirrhine, Platyrrhine, and lower Catarrhine *Quadrumana;* most *Non-claviculate Rodentia;* nearly all *Sectorialia* (except Pinnigrada); the *Proboscidia**; some Artiodactyla, *e.g.* the Omnivorous *Suidæ*, and the Ruminants *Auchenia*, and *Giraffa;* the In-Enamellata *Edentula;* and most *Marsupialia* (exc. see above).

d. The *Ruminant type* obtains in

most *Perissodactyla* (*e.g.* Tapir and Horse); and most *Ruminant* (Bovidæ) Artiodactyla.

—*Arterial Retia Mirabilia.*

Quadrumana. The Limb arteries of the Slow Lemurs (Stenops) exhibit a plexiform arrangement as in the Sloths (Bradypodidæ).

Sectorialia. The Ophthalmic artery (a branch of the external Carotid) forms in the Cat a vascular plexus in the Orbit. The Brachial artery has a plexiform arrangement in the Walrus.

Artiodactyla. In the Ruminantia a similar orbital plexus is found as in the Cat (*supra*): in the Hog and Ruminantia 'retia' are also found in the nasal cavities, formed by the Sphenopalatine artery: again, there is an intracranial 'rete' at the base of the skull in Ruminants; it is large in grazers (esp. Bovidæ), is less in browsers, and least in the Giraffe, which habitually feeds with the head raised.

Cete. In Phocæna the Intercostal arteries divide into a vast number of branches, forming by their close tortuous interlacement a plexiform mass: from which branches pass into the neural canal, to surround the spinal cord with a similar plexus which increases in thickness near the skull. Thus the neural axis can receive its

* Owen. Wagner (p. 45) says that both the Carotids are given off from a single common trunk, situated between the two subclavian arteries; and quotes it as a very rare arrangement.

appropriate stimulus of oxygenated blood during the periods of long submersion and consequent interruption of respiration to which the Cete are subject. The brachial artery also of Phocæna has a plexiform distribution.

Sirenia. The littoral and herbivorous Sirenia, which never go so deep, or stay so long submerged as the whales, are said not to possess either of the plexuses above described. The brachial artery has a plexiform arrangement in Manatee.

In-Enamellata. The brachial artery is remarkably modified in the Sloths, where, after bending over the first rib and traversing the axilla, it suddenly sends off, or seems to break up into a fasciculus of minute longitudinal branches which surround and conceal the main trunk which exists in the middle of the plexus. A femoral plexus is also given off at the brim of the pelvis by one or two branches which subdivide, but not, as in the axilla, by many ramuscules from one point. Rete have been noticed on the blood vessels of the limbs in Myrmecophaga didactyla, and Dasypus sexcinctus also.

Monotremata. The arterial system of both genera is characterised by the subdivided plexiform disposition of many of the arteries.

—*Origin of arteries of posterior extremities.*

Marsupialia. In the Kangaroo and Vulpine Phalanger the Aorta gives off, opposite the interspace of the two last lumbar vertebræ, the iliac arteries; but these are afterwards resolved into the ordinary branches of the external iliac of the placental Mammals, with the addition of the ilio-lumbar artery. The trunk of the Aorta, much diminished in size, maintains its usual course for a very short distance, and then gives off the two internal iliacs, and is continued as the 'arteria sacra media' to the tail. The transitional character of this part of the Marsupial sanguiferous system, between the Oviparous and Placental types, is manifested in the large size of the external* iliacs as compared with the internal iliacs, their greater share in the supply of blood to the hinder extremities, and the brevity of the Aortic trunk between their origins. In Marsupialia the inferior mesenteric artery does not arise primarily from the Aorta.

4. *Venous system.*

—*Valves.*

* In most Birds the femoral, or external iliac, are smaller than the ischiadic, or internal iliac, arteries subsequently given off.

Artiodactyla. The Portal vein shows valves in some Ruminants.

Cete. The non-valvular structure of the veins is remarkable.

—*External circular fibres.*

Sectorialia. The hepatic veins in the Seal have an outer coat of circular fibres. Wagner remarks that a peculiar annular muscle, about an inch in breadth is met with in the Seals on the trunk of the inferior cava above the diaphragm and venous sac, which can cut off the return of blood to the heart.

—*A right and a left vena cava superior* are found in

some *Insectivora, e.g.* Hedgehog; some *Cheiroptera, e.g.* Bat; most *Rodentia, e.g.* Rabbit, Squirrel, Rat, Mouse; in the *Proboscidia;* and in all *Marsupialia* and *Monotremata.*

—*A right vena cava superior and a left azygos venous trunk,* prevails in most of the larger quadrupeds: it is found in

some Insectivora, *e.g. Talpa;* some Rodentia, *e.g. Cavia;* some Perissodactyla, *e.g. Horse;* and some Artiodactyla, *e.g.* the Omnivorous *Suidæ,* and many Ruminantia *Cavicornua.*

—*A right vena cava superior and a left cardiac venous trunk or coronary sinus,* prevails in the higher Mammalia,

e.g. in *Bimana;* many *Quadrumana;* most *Digitigrade, Semi-plantigrade,* and *Pinnigrade* Sectorialia; and nearly all *Cete.*

—The *Inferior cava is* more or less *dilated*

in some Rodentia, *e.g. Castoridæ;*

in some Sectorialia, *e.g. Lutra* and *Phoca* (in the latter this dilatation reaches to the greatest extent; it occurs close to, and almost within the liver, and extends to the diaphragm, above which the vein is again of the common width):

in the *Delphinidæ* (Cete) and the Monotrematous *Ornithorhyncus.*

—*Venous plexuses.*

Cete. The veins at the back of the Thoracic-abdominal cavity have a characteristic expansion and plexiform multiplication. The chief abdominal reservoir is formed by the vast psoadic* plexus which extends from behind the hinder end of the kidney to the hinder end of the abdomen: in the Porpoise it forms a mass of reticulate veins upwards of an inch in thickness. The caudal vein

* So called, as being situated between the psoas muscle and the peritoneum.

is represented by a plexus, and occupies much of the hæmapophysial canal.

5. The *Blood.*

—*Oval discs.*

Artiodactyla. The *Camelidæ* (*e.g.* Dromedary, Llama, Vicunga) have elliptical blood discs: but these are equally non-nucleate with the ordinary circular blood discs; and adhere to the Ruminant characteristic of minuteness of size.

—*Size of discs.*

The two extremes of size observed in the Mammalian class are in Elephas Indicus $\frac{1}{2745}$, and Moschus Javanicus $\frac{1}{12325}$*.

Artiodactyla. An unusually *small size* of the blood discs is associated with the peculiarities of the *Ruminant* structure.

* W. Hewson.

RESPIRATORY SYSTEM—General.

The Larynx, Trachea, and Lungs, in the Mammalia are fashioned after the type of the same organs in Man.

The cartilages of the *Larynx* are upon the whole the same as in Man, *viz.*, a Thyroid; a Cricoid; an Epiglottis; two Arytēnoids*; two Cartilagines Santorianæ, articulated with the summits of the arytenoids; and two Cuneiform Cartilages (Wrisberginæ), situated between the arytenoids and the epiglottis: but in addition there is sometimes found an 'Inter-articular †' cartilage, situated between the two arytenoid cartilages, upon the upper border of the cricoid. These cartilages, some of which are occasionally found ossified, are united together by ligament. Two pair of elastic fibres are commonly found stretched between the arytenoid and thyroid cartilages, *viz.* the 'upper' and 'lower' Vocal Chords, between which the lining membrane bulges outward to form the 'laryngeal' sac or 'ventricle.' The alæ of the *Thyroid* cartilage are generally, though not always, united, and form anteriorly an angle; though usually larger than the cricoid the thyroid is not always so: it may have no upper cornua; its lower cornua may be produced to meet the first tracheal ring; from its upper part sacculi may be continued into the interspace between the epiglottis and the Hyoid; and it may be itself hollowed out

* ἀρυταινα, a pitcher or ladle; εἶδος, shape.

† Brandt.

like a bulla, to receive a sacculus. The *Cricoid* is generally smaller than the thyroid, but may be even three times greater in size; it is usually complete anteriorly, but may be almost divided by a cleft: it is sometimes so extended posteriorly as to cover the five anterior tracheal rings. The *Epiglottis* is almost universally present, protecting the entrance into the Larynx; it may be entire, or notched at its apex; its sides are sometimes attached to the apices of the arytenoid cartilages; together with the arytenoids it may be enclosed by a sheath of pharyngeal mucous membrane; it may contain no true cartilage; and may be perforated by apertures leading into sacculi. The *Arytenoids* sometimes extend half way across the rima glottidis; they may be, as above said, enveloped with the epiglottis in a membranous sheath; and, together with the cartilages of Santorini, are sometimes confluent at their apices. The *Vocal Chords* are subject to great variations in point of development; both upper and lower 'chordæ vocales' may be reduced to half their normal extent, owing to the anterior extension of the arytenoids; the superior 'chordæ' may be represented by a slight thickening of the lower border of the lateral membranes continued from the arytenoids to the base of the epiglottis; again, the lower vocal chords may be alone manifested, and the interchordal ventricle obsolete: or there may be no vocal chords, and quasi-ventricles alone present; lastly, both the vocal chords and ventricles may be wanting. Certain species vibrate their vocal chords by currents of air in alternate opposite directions, but this is exceptional. The interchordal ventricles when present vary much in relative size; they may be subdivided into several pouches. Above the convergence of the upper chords is sometimes found the opening of a 'hyoid sac,' the basi-hyal bone being hollowed out to receive this sac. Some species of Mammalia are always mute: others are mute except at the sexual

season: Gibbons (Hylobates) alone of brute Mammals may be said to sing.

The *Trachea* is kept open by cartilaginous hoops, which may be complete or cleft: when cleft, the ends of each ring may meet and touch, or overlap, or (as is commonly the case) may be separated even to the extent of a quarter of the circle, the intervening space being occupied by membrane: this separation very rarely occurs on the anterior surface. The cartilages of the rings may be continued spirally into one another; and the rings themselves may be occasionally found ossified. The number of rings varies, from three (Dugong) to a hundred (Camel). The entire tube is lined by a mucous membrane with a ciliated free surface. The trachea as a rule passes with a *straight* course until its subdivision into bronchial tubes. As a rule there are two *Bronchi,* but there is occasionally found a third smaller bronchial tube which passes to the right lung. The bronchi when within the substance of the lung divide and gradually lose their tracheal structure; the cilia ceasing when the divided bronchial tubes again subdivide to form the numerous 'intercellular' passages: the intercellular passages intercommunicate, which the bronchial ramifications never do. The arborescent subdivisions of the intercellular passages terminate in air cells, in size from $\frac{1}{6}$ to $\frac{1}{20}$ of a line: on the parietes of these cells the pulmonary capillaries offer only one side to the respiratory medium, instead of being wholly immersed in the extra-bronchial air as in Birds. Air sacs in connection with the lungs, as are observed in Birds, are not present in Mammalia.

The *Lungs,* minutely cellular throughout, are suspended freely in a thoracic cavity, separated by a musculo-tendinous partition or 'diaphragm' from the abdomen. *A complete Diaphragm is peculiar to Mammalia;* it is attached to the vertebræ, the ribs, and the sternum, and is tendinous in the

middle; occasionally a small bone is found in its tissue. The serous membrane covering each lung is reflected from the root of the lung upon the walls of the thorax, thus constituting a so-called 'pleural' sac. The *pleural serous sacs are peculiar to Mammalia.* The right lobe of the lung is usually the larger, and is very commonly subdivided: the left lobe is frequently undivided, and when divided has generally fewer lobes than the right. The lungs may be simple and undivided, as in Man, but exceptionally. The most common Quadrupedal difference from the Bimanal type is the lobe called 'azygos,' or 'impar,' detached from the right lung to occupy the space between the heart and the diaphragm.

RESPIRATORY SYSTEM—Special.

1.—The *Thyroid.*

Quadrumana. In most Platyrrhina the upper border of the Thyroid is emarginate. In Mycetes (Howler) the Thyroid is twice the size of that of Man, and has a strong anterior prominence, bulging out there to lodge a pair of sacculi continued from the fore part of the long interchordal cleft or ventricle. In Stenops (Lemuridæ) the lower cornua of the Thyroid are produced over and beyond the Cricoid to be connected with the first tracheal ring.

Artiodactyla. In the Hog there are no upper cornua to the Thyroid; and in the Camelidæ the upper cornua are represented only by tubercles.

Sirenia. The cartilaginous wings of the Thyroid are not confluent, but are joined anteriorly for a short way by sclerous tissue, and below this by membrane and areolar tissue.

Monotremata. In Ornithorhyncus the lateral alæ of the Thyroid are bony, and each of them bifurcated: one of the processes extending to the posterior part of Pharynx, where it becomes cartilaginous, and is confluent with the corresponding process of the opposite side.

2.—The *Cricoid.*

Sectorialia. In *Ursus* the Cricoid is almost divided by an anterior cleft.

Proboscidia. The Cricoid extends posteriorly over the first three tracheal rings.

Artiodactyla. In the *Elk* (Alces) the Cricoid is expanded behind and thence produced downward so as to cross the five anterior tracheal rings.

Cete. In *Phocæna* the Cricoid is incomplete at the fore part.

Sirenia. The Cricoid is larger than the Thyroid, and forms a complete ring.

3.—The *Epiglottis.*

Rodentia. The Epiglottis generally has a bifid apex, and at its base small cartilaginous styliform bodies, separated by a triangular space.

Perissodactyla. In the Ass and Tapir the root of the Epiglottis is perforated by two apertures, leading to two sacculi continued upon part of the inner surface of the Thyroid.

Cete. In Phocæna the long Epiglottis is enclosed with the Arytenoids in a sheath of pharyngeal mucous membrane so as to form therewith a long pyramidal projection, with a slightly expanded apex, which is encircled, as it were grasped, by a sphincter-like disposition of the muscles of the soft palate.

Sirenia. There is no true Cartilage in the Epiglottis of Dugong.

In-Enamellata. In the Armadillos the Epiglottis is deeply notched at the apex.

Marsupialia. The Epiglottis is remarkable for its large size and generally for its emarginate apex. There is no muscle passing from the Epiglottis to the tongue. In *Perameles* and *Phascogale* the sides of the broad and short Epiglottis are attached to the apices of the Arytenoid Cartilage.

Monotremata. In Ornithorhyncus the apex is notched.

4.—The *Arytenoids.*

Perissodactyla. In Rhinoceros the base of the Arytenoid cartilages extends half way across the aperture of the Larynx, and from the anterior extremities of these produced bases, the upper and lower ‘chordæ vocales’ extend forward to the Thyroid cartilage and base

of the Epiglottis. Only the anterior half, therefore, of the 'rima glottidis' is bounded by vibratile vocalising material.

In most *Insectivora* and *Cheiroptera*, and some *Artiodactyla* (*e.g.* Hog), the Arytenoids are united at their apices by the conjunction of the Santorinian cartilages.

For Arytenoids (1) sheathed with, or (2) attached to Epiglottis, cf. supra—3. *Cete*, and *Marsupialia.*

5.—*Interarticular Cartilage.*

In most *Cheiroptera* and *Insectivora* (*e.g.* Hedgehog) there is a triangular cartilage between the bases of the Arytenoids and the Cricoid called by Brandt 'Interarticular.'

6.—*Chordæ Vocales*, and *Ventricles.*

Quadrumana. No tail-less Ape has a hyoid sac: but in the Orangs the sacculi continued from the interchordal ventricles pass out between the Thyroid and Hyoid, and in the adult males extend over the fore part of the neck and upper part of the chest, being subdivided into several pouches.

Mycetes appears to have four sets of sacs: (*a*) from the fore part of the interchordal space, a pair of sacculi are developed which occupy the thyroid bulla; (*b*) from the upper part of the thyroid-sacculi are continued a pair of 'pyramidal oval' sacculi, which occupy the sides of the interspace between the epiglottis and the hyoid; (*c*) from the fore part of the thyroid sac is continued the neck of the large 'infundibular sac,' which expands to occupy and line the bulla of the basihyal; lastly, (*d*) between the glottis and arytenoids are the orifices of a pair of pouches, continued rather from the pharyngeal than the laryngeal membrane, which extend forward and upward on each side of the epiglottis.

Rodentia. In the Porcupines both the Vocal Chords and the Ventricles are wanting.

Sectorialia. In the Badger the laryngeal sacs are deep and bifid: one portion extending to the root of the tongue, the other to between the Thyroid and Cricoid cartilages. In the Felidæ the upper Vocal Chords are unusually prominent, and by their vibration cause the purring sound.

Proboscidia, most *Perissodactyla*, and many *Artiodactyla* (*e.g.* Camelidæ, Alces, &c.) have the upper Chords barely definable.

Cete have no Vocal Chords; but at the base of the Epiglottis are two lateral glandular fossæ representing the 'Ventricles.'

In-Enamellata. In both Dasypodidæ and Bradypodidæ the superior Vocal Chord is absent, and the Ventricles are obsolete or shallow.

7.—Species that are *Mute*.

Of the Rodentia, the *Porcupines* are mute, save at the rut, when the male emits a low grunt.

Of the Artiodactyla, the *Giraffe* is mute, save at the sexual season.

The *Marsupialia* as a rule have little or no voice.

8.—The *Trachea*, &c.

— Rings *ossified*.

In *Ornithorhyncus* the bronchial annuli are bony.

— Rings not closed *anteriorly*.

Cete. In the *Balænidæ* the rings are interrupted by a membranous portion on the anterior surface; a peculiarity which is *unique among Mammals*.

— Rings are *complete*

in some Perissodactyla (*e.g. Horse*), Artiodactyla (*e.g. Ruminants*), Cete, and Marsupialia.

— Rings *overlap*

in most *Sectorialia*.

— *Trachea convoluted*.

In-Enamellata. In Bradypus tridactylus the trachea is convoluted as in the Nilotic* Crocodiles; it descends nearly to the diaphragm, and then curves upwards again before it divides into the two bronchi.

— Trachea *divided by median septum*.

Rodentia. In the Cape Jerboa (Helamys) is found a tracheal structure recalling the early division of the tube in Reptiles; the Trachea being divided a little beyond the Larynx into two canals by a median septum; as if the bronchi began there, and were continued, adhering, some way before diverging to the lungs.

— Trachea divides into *three main bronchial trunks*

in most *Artiodactyla* (*i.e.* Ruminantia and Hog) and in the *Cete*.

— Bronchi with *spiral coils*.

Sirenia. In the Dugong the cartilages of the bronchial tubes are continued spirally into one another.

9.—The *Lungs*.

— Simple and undivided

in *Bimana*, *Proboscidia* (where, however, the right lung sends off a lobular *process*), and *Cete*.

* Not in the Alligator or Gavial.

URINARY ORGANS—General.

The Mammalian *Kidney* is distinguished from that of all other Vertebrata by the bipartite division of its substance into a 'cortical' and a 'medullary' portion. The *Cortical,* secretory portion, is highly vascular, and composed mainly of *tortuous* tubes, which, taking their origin from the Malpighian bodies, converge towards the interior and *do not spread to the exterior of the gland.* The *Medullary,* excretory portion, is composed mainly of *straight* tubes converging to meet at the apex of the medullary pyramid: it contains no Malpighian bodies. The secreting tubuli generally terminate by one or more papillæ in a dilatation at the commencement of the ureter called the pelvis. In many Mammals the right kidney is placed higher than the left; the reverse of that commonly observed in the Human subject. The Renal artery alone, derived *directly from the aorta,* supplies both the substance of the kidney and the secreting organism: in discharging the latter function, the afferent vessels form vascular tufts in the Malpighian bodies, and the efferent vessels proceeding thence form capillary plexuses surrounding the uriniferous tubes. The Capillaries after they reunite to form venules round the papillæ sometimes assume a starlike, or an arborescent disposition, or even form a network on the *surface* of the kidney prior to dipping down through the cortical septum to emerge at the hilus. In all cases the ultimate venous trunks terminate in the vena cava inferior and their component *veins never anastomose with the Intestinal veins.* In the Human Embryo the Kidneys consist of several masses or lobes, as it

were a multiplication of simple kidneys; in some species they continue in this form during the whole of life: this is particularly the case in those that live in water. When a kidney, is thus subdivided, *each 'renule' has its own excretory duct.* The Ureters almost invariably terminate in a Urinary bladder, and have an oblique valvular course through its coats. The Bladder appears to be smaller in those species that feed on flesh than in those that feed on herbs.

URINARY ORGANS—(Special).

1.—*Lobules.*

Sectorialia. In the Phocidæ (Pinni-gr.) the kidney is divided into from seventy to one hundred or more lobules, and its surface has in consequence a tesselated aspect.

Cete. The kidneys have a racemiform appearance; in the Dolphins two hundred separate lobules can be counted.

2.—*Papillæ.*

The following Species generally have only a single papilla into which all the renal tubuli open, *viz.*:

all *Catarrhine* Quadrumana: and most *Rodentia, Sectorialia, In-Enamellata,* and *Monotremata.*

3.—*Termination of Ureters.*

In the *Monotremata* the ureters do not terminate in the bladder, but in the urogenital canal; the orifice of the sperm duct, or oviduct, intervening between that of the ureter and the bladder. The urine may dribble out with the fæces, or may pass by a retrograde course into the bladder; but in either case it is expelled *per cloacam,* not per urethram.

4.—*Superficial ramifications of veins, &c.*

In most *Digitigrade* Sectorialia (Felidæ, Hyænidæ, Viverridæ, and Suricate), the kidney is remarkable for the *arborescent* disposition of the veins on or near the surface. In *Phoca* (Pinni-gr.) the veins unite to form a *network* on the surface of the kidney.

PECULIAR GLANDS.

In certain Genera and Species peculiar glands are found subserving special functions; *e.g.* sebaceous follicles of the skin secreting a strong smelling, unctuous fluid; anal sacs, or glands; and others on the back, legs, and feet.

Quadrumana. In Cheiromys, and some other Lemuridæ, the anal glands are reduced to two shallow cutaneous pits at the sides and upper part of the vent; in higher Quadrumana this trace disappears.

Insectivora. In many Shrews two longitudinal series of glandular tubes open upon the sides of the body opposite to the anterior feet, the secretion of which has a more or less musky odour; and in certain large Shrews (*e.g.* Macroscelides) the under part of the base of the tail is tumid, through the development of the glandular follicles.

Cheiroptera. In certain tropical bats (*e.g.* Cheiromeles) a glandular exuding sac is situated near the axilla: and in some Vespertitiones upon the sides of the upper jaw.

In the *Rodentia* and *Sectorialia* anal sacs, and preputial glands close to them, are of frequent occurrence, especially noticeable in Castoridæ (Rodentia) and Viverridæ (Sectorialia).

Proboscidia. In Elephas a large gland is situated in the temporal region, especially developed in the rutting season.

Artiodactyla. Interdigital glands are generally found which exude their lubricating secretion from an orifice at the upper and fore part of the cleft between the principal hoofs. In Dicotyles is found a gland situated rather posteriorly upon the mid-line of the

back*. In many Ruminants and Hogs an inverted fold of skin just below the orbit ('suborbital sinus') receives the secretion of numerous sebaceous follicles by which it is perforated. Glandular depressions of the skin situated in the groin ('inguinal pits') are found in many Antelopes, and are especially noticeable in the small Ruminant called on account of the odour of the secretion 'Musk Deer.'

In-Enamellata. The short vestibule or cloacal passage of the two-toed Sloth shows orifices of many sebaceous follicles.

In all *Marsupialia* there are two cavities with sebaceous follicles opening into or near to the termination of the rectum.

Monotremata. In the male Ornithorhyncus and Echidna there is a considerable triangular gland on the outer side of the leg, between the femur and the long olecranoid process from the head of the fibula; the duct from this descends down the back of the leg to the tarsus, where it suddenly expands into a vescicle applied to the base of the spur (cf. Osteology) and is thence continued as a minute duct into the canal which traverses the spur, and which terminates by a fine longitudinal slit about one line distant from the point.

* The resemblance of this orifice to the navel on the opposite part of the trunk suggested to Linnæus the term Dicotyles for this genus of S. American porcine animals.

NERVOUS SYSTEM.—General.

The *Spinal Cord,* or Myelon (of Owen), exists in various proportions relatively to the neural canal in different Mammals: but the mass of the Myelon, with but few exceptions, bears a direct ratio to that of the body throughout the series, has essentially the same structure, and is much less than that of the brain. It extends considerably further posteriorly in other Mammalia than in Man, as a rule reaching as far as the Sacrum*. As in the rest of Vertebrata, a central canal is often found in the Mammalia, especially in the fœtus; it is more obvious in lower Mammals than in Man. Two enlargements are generally found in the Cord; one in the region of the attachment of the anterior limbs (brachial); the other where the lumbar and sacral nerves arise, which form the plexus for the hind limbs (pelvic): the pelvic enlargement is wanting when the hind limbs are rudimentary; it never exhibits a rhomboidal sinus (*cf.* Aves): the brachial enlargement is distant from the medulla oblongata, according to the length of the 'neck.' The Spinal Cord generally terminates posteriorly by breaking up into threads, forming the so-called 'cauda equina,' which is scarcely ever met with in the cord of the other Vertebrata.

* The Ornithorhyncus hardly departs from the condition of the Lizard, the Myelon extending into the sacrum, and having the intravertebral nerve roots limited to the short canal of the caudal region.

The *Brain*, or Encephalon, presents four primary segments or divisions, named respectively from back to front. 1. Epencephalon. 2. Mesencephalon. 3. Prosencephalon, and 4. Rhinencephalon.

1. The hindmost division, or *Ep-encephalon*, consists of the Macromyelon (= 'medulla oblongata,' + the intracranial prolongation of the myelonal columns as far forwards as their emergence from the Pons), and the Cerebellum, together with its transverse Commissure, called 'tuber annulare,' or Pons Varolii. From the Macromyelon the cerebral nerves, from the fifth to the hypoglossal (or ninth) inclusive, arise. In most Mammals below Man, a transverse section of the Medulla oblongata, in the region of the first cervical nerve, presents the form of an ellipse, as opposed to that of a circle, as in Man. The *Olivary bodies* do not always present internally a 'corpus dentatum,' or nucleus with plicated capsule of white neurine: they are frequently crossed before reaching the Pons by the trapezoid homologues of the arciform fibres in Man. The *Trapezium*, which is found in most Mammals, except Man, consists of a quadrangular elevated layer of transverse medullary fibres, which lies close behind the Pons, near to the pyramidal bodies, and abuts against the origin of the auditory and facial nerves. The middle lobe of the Cerebellum is the most constant part in the Vertebrate series, but by no means always holds a large proportional size, as compared with the lateral lobes. *The addition of Lateral lobes to the Cerebellum is characteristic of the Mammalian Class.* An 'appendicular lobe,' a subspherical lateral process or appendage to the hemispheres of the Cerebellum, is sometimes found. To the 'flocculus' the origin of the acoustic nerve can be traced; it is generally associated with large external ears, and a well-developed auditory organ. In Mammals the ventricle of the Cerebellum, which is persistent in Fish, Reptiles and Birds, is obliterated. The *Pons* is found in all Mammals,

and *by it the Mammalian brain may be distinguished at its base from that of other Vertebrata:* the size of the Pons is directly correlated with the development of the lateral lobes of the Cerebellum.

2. The division of the Brain next anterior to the Epencephalon is termed the *Mesencephalon:* it includes the Nates and Testes, third Ventricle, and Pineal and Pituitary glands*. The Nates, or 'optic lobes,' are expansions of the processus ad testes, or crura ad cerebrum (superior peduncles of Anthro.); the layer (valvula) uniting these two crura becomes thickened by transverse white fibres behind the optic lobes, and these in the higher Mammals swell into a second pair of tubercles, the Testes, which usually exceed the Nates in breadth, but are less in length. In the groups in which the eyes are relatively largest, the large proportional size of the homologue of the optic lobes is significant of their important relationship with the origin of the nerves of vision. These 'Corpora quadrigemina' form a much smaller mass of the brain than in the lower Vertebrata, are not hollow internally†, and, though in most Mammals covered by the Cerebral Hemispheres, are in some genera more or less exposed between the Cerebrum and Cerebellum. The third Ventricle has no continuation into the optic lobes, which it has in oviparous Vertebrata; its ascending canal to the Pineal appendage is obliterated, but the descending canal to the Pituitary body is retained as the Infundibulum. The third Ventricle is formed by the vertical expansion of the 'iter a quarto ad tertium ventriculum,' which is itself a forward continuation of the

* The third ventricle extends upwards into the pedicle of the Conarium (pineal gland) and downward into that (infundibulum) of the hypophysis (pituitary gland). Owen iii. 97.

† Van der Hoeven. Wagner says (p. 23), 'the Corpora Quadrigemina are very frequently provided with an internal cavity.' In the *fœtus* of Man and Mammals these eminences are at first single on each side, and *have an internal cavity, communicating with the ventricles.* Q. and S. 554.

primitive Myelonal cavity, traversing the Mesencephalic basis.

3. The third primary division of the brain, anterior to the Mesencephalon, is termed the *Prosencephalon:* it includes the Crura Cerebri anterior to the Nates, the Thalami Optici, Corpora Striata, and Cerebral Hemispheres with their commissures. The Cerebral Hemispheres attain a greater development than in any other class of Vertebrata: they are connected together in all Mammals, as in Birds, by the cord-like fasciculus of transverse fibres, called the 'anterior commissure': but the main distinction lies in the superaddition, to the 'diverging' or 'crural' fibres, of other commissural tracts; either longitudinal, connecting parts of the same Hemisphere; or transverse, bringing the greater portion of the two Hemispheres into mutual communication. The Hemispheres are always connected by a more or less extensive Corpus Callosum: but in descending the series from Man to those Placental Mammals of lowest cerebral organization, a great change is seen in the condition of the Corpus Callosum, in the disappearance of the rostral portion, and coincident greater development of the posterior folded or psalterial portion; the latter being connected with the relative increase of the hippocampal region of the Cerebrum: a change of precisely the same nature is seen carried to an excess in the brain of the Marsupial. The anterior Commissure diminishes in size in proportion as the Corpus Callosum increases in extent. The Corpus Callosum increases directly as the growth and complexity of the Hemispheres. As the Hemispheres increase, in the Placental series, so does the extent of the filmy inner walls of the lateral ventricles ('septum lucidum,' Anthro.) between the body of the Fornix and the Corpus Callosum. Each Hemisphere of the Cerebrum begins as a vesicle of neurine, the cavity of which receives the growth from the 'crura,' forming the 'Corpus Striatum'; this, in Birds, mainly fills the 'Ventricle' or rem-

nant of the primitive cavity of the sac: but, in Mammals, the wall of the vesicle is augmented by folds, of which the first and most constant is pushed from the mesial or inner side of the ventricle into its cavity, giving rise to the convexity, representing the part called 'hippocampus' in Anthropotomy. The anteriorly continued and transversely connected longitudinal fibres of the Hippocamp constituting the Fornix, furnish a further distinctive characteristic of the Mammalian as compared with the Avian brain. An intercommunication between the two Prosencephalic cavities (lateral ventricles) defined in Anthropotomy as the foramen of Monro, exists in all Mammals. The extent to which the Hemispheres are developed posteriorly is very variable, being in some genera so slight as to leave the Corpora Quadrigemina exposed, and being seldom sufficient to entirely cover the Cerebellum. In proportion to the increase of the Cerebral Hemispheres there is a diminution in the size of the ganglia immediately connected with the organs of sense. The external surface of the Hemispheres is generally convoluted, but there are several Orders and Genera in which the surface is smooth, as it is in the brain of the Oviparous Vertebrata.

4. The foremost primary division of the Brain, termed the *Rhinencephalon*, includes the anterior termination of the columnar tracts (the 'roots of the olfactory nerves' in Anthro.), and the appended vesicular mass called 'olfactory lobe' (the 'bulb of the olfactory nerve' in Man). In most Mammals the 'lateral ventricles' of the Prosencephalon are continued into the Rhinencephalon. As a very rare exception the 'olfactory bulbs' may be absent*.

Membranes of the Brain. A fold of dura mater is commonly found between the Cerebral Hemispheres termed the 'Falx'; a second duplicature is found between the Cerebrum and Cere-

* In a few Cete, *e.g.* Dolphin.

bellum, called the 'Tentorium;', and, exceptionally*, a third process between the lobes of the Cerebellum termed the 'Falx minor:' ossification is occasionally extended into both the Tentorium and Falx (major).

Nerves.—Olfactory nerves are present in all save one Order of Mammals, and are sent off in greater number from the Rhinencephalon than in lower Vertebrata: in one known instance alone does the olfactory nerve quit the skull by a single foramen (*i.e.* one from each Rhinencephalon), as in Birds and Lizards.

The *Optic* nerves, which rise chiefly from the 'nates,' develope in almost all Placentalia an oblong nodule of grey matter (corpus geniculatum of Anthro.) prior to bending round the outer and back part of the 'thalami,' from which they receive accessory filaments. At their confluence beneath the brain there is no trace of the laminated arrangement commonly found in the 'chiasma' of Birds and Reptiles: they generally leave the skull each by a special 'foramen opticum'. In those animals which have very small, rudimentary eyes, the optic nerves are very delicate.

The *Sixth Nerve,* besides supplying the 'rectus externus,' is also distributed in most Mammals to an additional, 'suspensory', muscle of the eye, not found in Man, *viz.* the 'retractor oculi.'

The *Fifth, or Trigeminal Nerve,* is frequently very much developed, being commonly the largest of the Cerebral nerves. The size of this nerve varies directly with the perfection of sensitiveness in the parts to which it is distributed, not with the proportion of the facial to the cranial part of the head. A distinct gustatory nerve, communicating with a motory 'facial' nerve by a 'chorda tympani' is an arrangement characteristic of the Mammalian trigeminal nerve.

* On account of the large vermiform lobe of the Cerebellum projecting beyond its Hemispheres.

Of the '*Seventh Pair*,' the *portio dura* (or facial nerve), traverses the parotid gland in those Mammals in which that gland is well developed. The large development of that part of the '*portio mollis*' (or auditory nerve) which supplies the cochlea is characteristic of the Mammalia; in which the posterior division, answering to the main part of the acoustic in lower Vertebrates, is spent upon the vestibule and semicircular canals.

Of the *Eighth Cerebral Nerve*, the 'glosso-pharyngeal' division is relatively smaller in Mammals than in Birds: it is mainly distributed to the back part of the tongue, and to the pharynx in all members of this Class. The *Vagus*, or 'pneumogastric division' has, as in the other Vertebrata, the longest course, widest distribution, and most numerous connexions of any of the Cerebral nerves; but is characterised, in Mammals, by receiving the 'accessory' nerve from a greater extent of the myelon. The 'recurrent' branches of the Vagus are more exclusively distributed to the trachea and larynx, and send a smaller supply of nerves to the œsophagus than in Birds or Reptiles. In most Mammals the Vagus after its exit from the jugular foramen, exhibits a grey enlargement; but this is less distinctly divided into an upper and lower ganglion than it is in Man.

The *Ninth*, or motor nerve of the tongue (hypoglossal) varies in size according to the length of the tongue and the frequency and extent of its muscular motion. In most Mammals the filaments of this nerve are collected into two bundles which pass out each by a single precondyloid foramen, but two foramina are occasionally found on each side.

The *Sympathetic* nerve system is much the same as in Man: it influences the contractile power of blood vessels, the coats of which, in all Mammals, show a considerable plexiform supply therefrom. In all Mammals the parts regarded as 'trunks,' or 'main cords' of the sympathetic, form a symmetrical pair, extending along the sides of the centrums of the Vertebræ, forward to the basioccipital, and backward to the coccyx.

NERVOUS SYSTEM.—Special.

1.—*Spinal Cord, or Myelon.*

— The *proportion of, to Neural Canal,*
is greatest in the *Pinnigrade Sectorialia* (*e.g.* Seal), the *Cete,* and the *Sirenia.* The space between the myelon and neural arches is occupied by blood vessels, which are chiefly arterial plexuses.

— The *Mass of, is in direct ratio to that of the body,*
except in certain Insectivora, *e.g. Hedgehog,* a *few Cheiroptera,* and the Monotrematous *Echidna.*

— *does not extend as far as Sacrum*
in *some Cheiroptera,* the *Hedgehog* (Insectivora), and the *Echidna* (Monotremata); the myelon being concentrated into the dorsal region.

— *presents only the anterior enlargement*
in the *Cete,* and *Sirenia.*

2. *Brain,* or *Encephalon.*

i. *Bimana.—Membranes.* In Man (as also in most Quadrumana) the sole ossification co-extended with any part of the dura mater is that called 'crista galli' (in Anthro.). An unossified process from the middle of the posterior border of the tentorium, extending from the internal occipital crest, projects into the notch between the hemispheres of the Cerebellum, and is termed falx minor, or falx cerebelli.—*Epencephalon.* A thin layer of superficial fibres, which in lower Mammals with non-prominent 'olivary' bodies pass outward as a 'trapezoid' layer, in Man curve round the exterior of the olivary prominences and constitute the *arciform* fibres. The 'corpus dentatum' is well marked. The transverse section of the medulla oblongata is nearly circular. The lateral lobes of the cerebellum acquire the largest proportions (as compared with other Mammals), and reduce the middle lobe to the semblance of a subordinate adjunct, called 'vermiform process.'—*Mesencephalon.* The corpora quadrigemina are small in comparison with those of the lower Mammalia.—*Prosencephalon.* The Human Brain surpasses that of all Mammalia in its greater proportional bulk to that of the body, and

in the still greater proportional size of the cerebrum to the rest of the brain, *viz.* as 8 to 1. The anterior commissure has but insignificant dimensions. The cerebral hemispheres completely overlap the cerebellum: the middle lobe is well defined.

ii. *Quadrumana.—Membranes.* In the matter of the 'crista galli,' see *Bimana.* In Cebus and Ateles the tentorial margin of the petrosal is slightly produced.—*Epencephalon.* In the Anthropoid Apes the *arciform* disposition of fibres in conjunction with the olivary bodies prevails instead of the 'trapezoid' found in all other Orders below. The 'appendicular lobe' of the cerebellum is present in most Lemuridæ (*e.g.* Aye Aye), and is lodged in a special pit of the petrosal: but in the large Catarrhina the lateral lobes increase in size, and lose or incorporate the appendix. The flocculus is present in all Quadrumana, and is well marked in he timid and sharp-eared nocturnal Aye Aye.—*Prosencephalon.* In the Lemuridæ the cerebrum does not extend over the whole of the cerebellum. In the diminutive Midas the upper surface of the hemispheres is smooth. The brain of several genera of Apes resembles that of Man* in the posterior development of the cerebral hemispheres specialized as the 'third lobe;' in the possession of a posterior horn to the lateral ventricle (*e.g.* in Orang-utan); and in the presence of a hippocampus minor (Orang-utan)†.

iii. *Insectivora.* All the four primary segments are in view from above and succeed each other from behind forward (*e.g.* Rhynchocyon, African shrew) as in Reptilia.—*Epencephalon.* The cerebellum presents few transverse convolutions; the median, or vermiform lobe is large relatively to the lateral lobes; he pons rather small.—*Mesencephalon.* The corpora quadrigemina‡ are large and exposed between the cerebrum and cerebellum.—*Prosencephalon.* The cerebrum does not extend over the cerebellum; each hemisphere is much contracted anteriorly. The corpus callosum is of limited extent; the hippocampi relatively large: there is no septum lucidum. The lateral ventricles are continued into the rhinencephalon. The cerebral

* Huxley. Comp. Anat. (Ed. 1864). pp. 98-100.

† For the complete elaboration of the comparison of the convolutions of the Brain of Man as compared with that of the Apes the student should consult M. Pierre Gratiolet's "Memoire sur les Plis Cerebraux des Hommes et des Primates," of which the Appendix to this chapter is a summary.

‡ The 'optic lobes' of Talpa show no reduction of bulk commensurate with that of the visual organ.

hemispheres are devoid of sulci (*e.g.* Sorex, Talpa, Erinaceus). The *Rhinencephala* are long, large, and pyriform.

iv. *Cheiroptera* present the same type of brain as the Insectivora, except that the cerebral hemispheres present a few simple folds on their exposed surfaces.

v. *Rodentia* also, have a similar brain to the Insectivora, except that the lateral lobes of the cerebellum are larger relatively to the median lobe (esp. in Hare), though that still retains its large size. The cerebellum is as a whole proportionally greater to the rest of the brain in Rodentia than in other Mammals. The anterior pair (nates) of the corpora quadrigemina are larger than the posterior. The cerebral hemispheres in the smaller species (*e.g.* Lepus, Cavia) have only a very few shallow depressions; they do not always, though generally (*e g.* Lepus, Castor), leave the corpora quadrigemina exposed. The cornu ammonis and corpus fimbriatum are usually found very large: and the corpus callosum is of greater relative extent than in Insectivora.

vi. *Sectorialia.—Membranes.* For the ossification of the tentorium, see Osteology, sub. *Sectorialia.* In seals both the tentorium and hind part of the *falx* are ossified, and a thick ridge enters the fore and under part of the falx between the rhinencephalic fossæ.—*Epencephalon.* The cerebellar hemispheres are more highly organised than in the Rodentia: the smallest species have the smallest lateral lobes in proportion to the middle one.—*Mesencephalon.* The posterior pair (testes) of the corpora quadrigemina are the larger.—*Prosencephalon.* The cerebral hemispheres extend over part of the cerebellum: in many of the Sectorialia they exhibit nothing more than a few shallow grooves. In the Dog, Otter, and Seal, the convolutions are far more numerous than in the feline tribes. The corpus callosum is connected with the fornix by a septum lucidum.

vii. *Proboscidia.* In the Ungulata the relative size of the lateral lobes of the cerebellum increases with the bulk of the species, and attains its maximum in the Elephant. This genus is remarkable for a well developed cerebrum overlapping part of the cerebellum, and for the excess of convolutions on the cerebral surface.

viii. *Perissodactyla.* The cerebrum always extends over part of the cerebellum. In the *Solidungula* the cerebral convolutions are more numerous than in the majority of Sectorialia: the 'nates' exceed the testes in size.

ix. *Hyracoidea.* The cerebral hemispheres present but few and simple fissures.

x. *Artiodactyla.* In *Ruminantia* the nates exceed the testes in size.

xi. *Cete.* The olivary bodies are not covered by a 'trapezoid' layer of fibres. The brain is remarkable for its rounded form, and for the proportional size of the cerebellum, especially of its lateral lobes: the pons is large and prominent. The cerebral hemispheres are highly organised in the Dolphins; the sulci are very numerous.

xii. *In-Enamellata.* The cerebellum is not covered by the cerebrum; its vermiform portion is considerable. The corpora quadrigemina are not reached by the cerebral hemispheres. The smaller and especially the insectivorous species have smooth low triangular hemispheres, with small corpus callosum.

IMPLACENTALIA. The Prosencephalon presents the following differentiating characters*:

(*a.*) A peculiar arrangement of the folding of the inner wall of the cerebral hemisphere: a deep fissure, with corresponding projection within, continued forwards from the hippocampal fissure, almost the whole length of the inner wall. In other words, a hippocampus major (instead of being confined, as it is at least in the higher forms of Placental Mammals, to the middle or descending cornu of the lateral ventricle), extending up into the *body* of the ventricle, and constituting its inner wall.

(*b.*) An altered relation (consequent upon this disposition of the inner wall) and a very small development of the upper transverse commissural fibres (corpus callosum).

(*c.*) A great increase in amount, and probably in function, of the inferior set of transverse commissural fibres (anterior commissure).

xiii. *Marsupialia. Epencephalon.*—The Cerebellum presents transverse convolutions, few in the climbing Koalas and Opossums, more numerous in the locomotive Kangaroos: it is remarkable for the large proportional size of the median or vermiform lobe as compared with the lateral lobes, and the concomitant diminution of the 'Pons'. In nearly all there is a small, subspherical, lateral process or appendage more or less projecting and sometimes lodged in a peculiar fossa of the petrosal above the internal meatus. *Mesencephalon.*—In most Marsupials (Dasyurus, Didelphys) the corpora quadrigemina are more or less exposed between the Cerebrum and Cerebellum.

* Flower. Phil. Trans. 1865, p. 647.

Prosencephalon.—The Cerebral Hemispheres do not extend over the Cerebellum in any of the species: their external surfaces are un-convoluted in most Phalangistidæ, Peramelidæ, Didelphidæ (Opossum), and small Dasyuridæ

xiv. *Monotremata. Epencephalon.*—The grey matter does not form a corpus dentatum in the olivary tracts. The lateral lobes of the Cerebellum are very small, and, concomitantly, the Pons also, especially in Ornithorhyncus, where it assumes the form of a narrow band; but the median lobe is large, and in Echidna forms the main bulk of the Cerebellum. *Mesencephalon.*—The posterior pair (testes) of the corpora quadrigemina are not separated by a longitudinal groove. *Prosencephalon.*—In *Ornithorhyncus* the Cerebral Hemispheres overlap the Mesencephalon and reach to the Cerebellum: with the exception of the hippocampal fissure and the depression lodging the Rhinencephalic crus, the surface is unbroken and *smooth.* In *Echidna* the outer surface of the hemispheres is extended by *convolutions.* The ventricles are continued into the *Rhinencephalon,* which in Echidna is enormous.

3.—*Nerves.*

(*a.*) *Olfactory*

— are *absent*

in all the *Cete* save those with baleen, in which they are few and small.

— *exit* from skull.

In the *Ornithorhyncus* is the sole known instance of the Olfactory nerves quitting the skull by a single foramen, *i.e.* one for each Rhinencephalon.

(*b.*) *Optic.*

— *origin.*

The optic nerves seem to be derived more wholly from the thalami in *Man* than in most lower Mammals.

— *exit* from the skull.

In some *Marsupials* the optic nerve escapes by a cleft continuous with the 'fissura lacera anterior.'

— *size.*

The Optic nerves are *smallest* in the *Moles*; *largest* in the *Giraffe.*

(*c.*) *Trigeminal* or Fifth.

— This nerve attains its largest relative size in Ornithorhyncus

paradoxus, which, like the duck, uses its beak as a tactile instrument in the detection of its food.

— The *infraorbital* branch is often of remarkable size, particularly in those animals that are provided with a snout, or with large vibrissæ upon the upper lip, to the follicles of which it gives considerable branches.

— The *third division*, which supplies, from its ganglionic part, the sensitive and secreting surface of the long tongue, is much developed in *Echidna*. The size of the lingual branch of the trigeminal is still more marked in the *Pangolins* and *Ant-eaters*, esp. in Myrmecophaga jubata.

— The *dentary* branch of the Maxillary is large in *Rodentia* and *Proboscidia*, to meet the demands of the active and persistent matrix of the Incisors.

— The *palatine* nerves attain their maximum size in the *Balænidæ* in relation to the active and extensive growth of baleen.

(*d*) *Hypoglossal* or Ninth.

— *exit* from the skull.

The main roots of each hypoglossal, which quit the Macromyelon usually in two bundles, escape in many *Marsupials* by two precondyloid foramina.

— *size.*

In the *Giraffe* the motor nerve of the tongue is larger in proportion to the body than in the Ox; it is largest in the *Pangolins* and *Ant-eaters* in relation to the great length of the tongue, and frequency and extent of its muscular motions.

CEREBRAL CONVOLUTIONS OF THE ANTHROPIDÆ (MAN) AND SIMIADÆ (APES AND MONKEYS.)*

(Based on M.Gratiolet's *Memoire sur les plis Cérébraux de l'Homme et des Primatés.*)

Four structural peculiarities serve to distinguish the Brains of Man and of the Apes from those of all other animals :—these are

1. The rudimentary condition of the Olfactory lobes.
2. A perfectly defined Fissure of Sylvius.
3. A posterior lobe completely covering the Cerebellum.
4. The presence of a posterior Cornu in the lateral ventricles.

In the Brain of no other animal are these characters found to co-exist simultaneously.

The Lemurs are excluded from this group, because in them the Olfactory lobes are large, the Cerebellum is not completely covered, and there is no posterior Cornu in the lateral ventricles.

Although these four characteristics are sufficient warrant for classing an animal amongst the Apes, even if the external surface of its Brain be absolutely devoid of Convolutions, still wherever Convolutions do exist, they are always found to be parts of a definite ground-plan or type, which pervades the whole series.

Owing to its medium development, the Brain of Cercopithecus Sabæus displays most clearly the outlines of this ground-plan, as no obscurity arises either from obliteration of the component primary Convolutions, or from the development of secondary ones. In fact the surface of the Cerebral Hemispheres of the higher Apes and of Man is only a complication of that seen in the Cercopitheci, whilst that of the lower Apes is a simplification of it.

* This paper was communicated by S. J. Sharkey, Esq., B.A., Jesus College, Oxford.

In the Cercopithecus Sabæus the great Median Fissure divides the Brain into two Hemispheres; each Hemisphere having an external surface, and an internal surface. The *external* surface comprehends all that can be seen on taking a profile view of the Brain: the *internal*, all that is seen on looking at the surface exposed by severing the two Hemispheres from each other by a perpendicular section through the great Median Fissure and Corpus Callosum. The line formed by the junction of these two surfaces above, is the superior border: that formed by their junction below, is the inferior border. The most prominent point of the Frontal lobe, where the two borders meet anteriorly, is the anterior or Frontal extremity: the point where they meet posteriorly, is the posterior or Occipital extremity.

A. *External Surface.*

The lobes on the External Surface are,

1. Frontal.
2. Parietal.
3. Temporo-sphenoidal.
4. Occipital.

The Central lobe, or 'Island of Reil' is hidden within the lips of the Fissure of Sylvius, and corresponds with the inferior aspect of the Corpus Striatum.

The External Perpendicular Fissure divides the External Surface into an anterior and a posterior part: the posterior comprehending the Occipital lobe: the anterior being divided again into two by the Fissure of Sylvius. The portion above this fissure embraces the Parietal and Frontal lobes, that below it the Temporo-sphenoidal lobe.

1. The *Frontal lobe* is limited posteriorly by the ascending branch of the Fissure of Sylvius, or, as Mr. Huxley names it, the Antero-parietal Sulcus. It is divided into an Orbital lobule and a Frontal lobule, the former corresponding to that part which rests on the orbital plate of the Frontal bone. The convolutions of the Orbital lobule are inconstant: those of the Frontal lobule are three in number and all longitudinal in direction, *viz.* :—

a. Superior Frontal.—*b.* Middle Frontal.—*c.* Inferior Frontal, or Supra-ciliary.

2. *Parietal Lobe.* This Lobe is bounded anteriorly by the Antero-parietal Sulcus, posteriorly by the External Perpendicular Fissure.

Three well marked Convolutions belong to this lobe: two of them are vertical in direction, and are separated from each other by the Fissure of Rolando; these are, (*a.*) the anterior of the two, the First Ascending Convolution, (*b.*) the Second Ascending convolution: (*c*) the third is the Curved Convolution, which winds round the superior extremity of the Parallel Fissure: this Convolution has an ascending branch, and a descending branch which is continuous with the Middle Temporal Convolution.

3. *Temporo-sphenoidal Lobe.* This lobe lies below the Fissure of Sylvius. It embraces three Convolutions, which are usually oblique in direction; they are

a. Superior Temporal.—*b.* Middle Temporal.—*c.* Inferior Temporal.

The superior and middle convolutions are separated from each other by the Parallel Fissure, around the summit of which winds the Curved Convolution.

4. *Occipital Lobe.* The convolutions in this lobe are three in number, and take a longitudinal direction. They are

a. Superior Occipital.—*b.* Middle Occipital.—*c.* Inferior Occipital.

The anterior border of the Occipital lobe often, as here, is thin, and projects forward over the external perpendicular fissure: it is then called the 'Operculum.'

There are moreover on the external surface four *Bridging Convolutions,* two of which are of considerable classificatory importance; *viz.* those which connect the Parietal lobe with the Occipital.

The first passes from the posterior extremity of the Second Ascending Convolution to the Superior Occipital Convolution. The second passes from the summit of the descending branch of the Curved Convolution to the Superior Occipital. The third external Bridging Convolution connects the Middle Temporal with the Middle Occipital; the fourth connects it with the Inferior Occipital Convolution. The two latter are always superficial. The others are sometimes superficially, sometimes deeply placed.

B. *Internal Surface.*

About the middle of the Internal Surface is seen the *Great Central Aperture,* round which the Convolutions are ranged and through which the Crus Cerebi passes upwards. It is divided into

two parts by the Fissure of the Hippocampus, which bifurcates posteriorly. That portion of the Brain which is placed below this Fissure, together with the Fascia Dentata (Pli Godronné, *Grat.*), which does not come into view on the surface, is called the *Occipito-Temporal Lobe.* The rest of the internal surface is again divided into two by the Internal Perpendicular Fissure, which runs down from the superior border of the Hemisphere and stops short about on a level with the posterior extremity of the Corpus Callosum. That part of the Brain which is below or behind the Internal Perpendicular Fissure, and between it and the posterior part of the Hippocampal Fissure is the *Internal Occipital Lobule*; that above and in front of it is the *Fronto-parietal Lobe.*

1. The *Fronto-parietal Lobe* is divided by the great Fissure of the Frontoparietal Lobe into

a. An Inferior Convolution, Convolution of the Internal Zone, s. Convolution of the Corpus Callosum.—*b.* Convolution of the External Zone.

The Convolution of the Internal Zone expands posteriorly to form the Quadrilateral Lobule.

2. In the *Occipital Lobule* the Convolutions are inconstant.

3. The *Occipito-Temporal lobe* comprehends,

a. The Superior Internal Temporal Convolution (Pli Godronné, *Grat.*), which is placed above, and externally to the so-called anterior part of the Hippocampal Fissure and does not appear on the surface:

b. The Middle Internal Temporal, placed below the Hippocampal, and above the Collateral Sulcus of Huxley. This convolution ends anteriorly in a large Lobule—lobule of the Hippocampal Convolution (lobule de l'Hippocampe, *Grat.*),—and from the extremity of this lobule a little hooked process curves backwards, which is the Hook of the Hippocampal Convolution (Crochet de l'Hippocampe, *Grat.*):

c. The Inferior Internal Temporal which consists of parts of three Convolutions which also take part in the formation of the External surface of the Hemisphere; *viz.* the Inferior External Temporal,—Inferior External Occipital,—and the Middle External Occipital Convolutions.

Two *Bridging Convolutions* also belong to the Internal Surface. They connect the Quadrilateral with the Occipital Lobule, and are sometimes superficially sometimes deeply placed. They are the Superior Internal Bridging Convolution which passes from the summit

of the Quadrilateral Lobule, to the summit of the Occipital Lobule, where it is continuous with the Superior External Bridging Convolution: and,—the Inferior Internal Bridging Convolution which unites the base of the Quadrilateral Lobule with the Inferior extremity of the Occipital Lobule.

If the Brain of Man be taken as the standard of Cerebral development, the position of any Ape in a classification, which has the Nervous system for its basis, will depend upon the degree in which its brain resembles that of Man.

The most striking features of the *Human Brain* are—

1. Its great size and complexly convoluted surface.

2. The great development of the Frontal Lobe; and especially of the Superior Frontal Convolution, which is indicated,

(*a.*) By the position of the upper extremity of the Fissure of Rolando, which reaches the superior border of the Hemisphere at a point much further back than in the Apes' Brains:—

(*b.*) By the Antero-Parietal Sulcus meeting the Fissure of Sylvius, not just above the Bend of the Fissure of Sylvius, as in most Apes, but considerably further back:—

(*c.*) By the horizontal position of the Fissure of Sylvius, which is more especially due to the great development of the Superior Frontal Convolution.

3. The small extent of the Occipital Lobe.

4. The comparatively small, and but slightly projecting Temporo-sphenoidal Lobe.

5. The Obliteration of the External Perpendicular Fissure, owing to the great size of the two Superior External Bridging Convolutions, both of which are superficial.

6. The great Antero-posterior extent of the Corpus Callosum.

Amongst the Old World Apes there are three groups, headed respectively by the Orang-Utang (Simia Satyrus), the Chimpanzee (Simia Troglodytes), and the Gorilla, in each of which Cerebral development seems to be progressing on a different plan.

Thus, in the group of which the Orang is chief, in which the brain appears to be developing in the same direction as that of Man, the Frontal and Parietal Lobes gradually increase in size and complexity, the Occipital diminishing *pari passu*:—in the Chimpanzee the Frontal and Occipital lobes are most developed:—whilst in the Gorilla the Parietal and Occipital Lobes predominate.

The Brain of the Orang is more massive than that of the Chimpanzee, and that of the Chimpanzee than that of the Gorilla : but the Occipital Lobe in the Gorilla is larger than in either of the other two (a point of inferiority, since this lobe is so small in Man) ; and the Frontal lobe is lower : moreover the Convolutions are probably less complicated in the Gorilla's Brain : therefore the Gorilla has the least highly developed Brain of the three.

In the Chimpanzee the Occipital lobe is large,—its Operculum complete—the ascending branch of the Curved convolution generally rises in front of the Fissure of Sylvius, and ascends a considerable distance towards the superior border of the brain. The superior External Bridging Convolution is generally absent; the second is large, but does not usually come to the surface.

In the Orang the Occipital lobe is of moderate size.—the Operculum scarcely perceptible—the Curved convolution rises on a level with the summit of the Fissure of Sylvius—the superior Bridging convolution is large and superficial—the second present, but hidden.

In Man the Occipital lobe is very small, and there is no trace of an Operculum ; the origin of the ascending branch of the Curved convolution is on a level with the summit of the Fissure of Sylvius, and both the superior Bridging convolutions are large and superficial. Therefore these three leaders will rank as follows

1. Orang-Utang.
2. Chimpanzee.
3. Gorilla.

The convolutions of the Brain are arranged after the same plan in the Platyrrhine as in the Catarrhine Monkeys: and yet the former have very distinctive Cerebral characteristics, and such as are not found in the latter. Thus, besides the extreme reduction in the size of the Frontal lobe, and the enormous development of the Parietal in some, we find the second External Bridging convolution always superficial in Cebus Capucinus; the convolution limiting the summit of the Fissure of Sylvius hidden in Ateles, without any part of the fissure itself being covered; and the ascending branch of the Curved convolution continuous with the Superior Temporal in the same Monkey—arrangements which do not find a parallel in the Old World Series. The highest group (Sapajous, Grat.) contains Mycetes, Ateles, &c.; they take the first rank, owing to their having a comparatively larger Frontal lobe, and both superior External Bridging convolutions present. Next to these come Cebus Capucinus,

and Cebus Apella (Sajous, Grat.). The third group embraces, Callithrix, Nyctipithecus, Pithecia (Sagouins, Aotes, Sakis, Grat.). The fourth, the Hapalidæ, Hapale Œdipus, and Hapale Jacchus (Pinches and Ouistitis, Grat.).

The importance of such characters as the slanting direction of the ascending convolutions of the Parietal lobe, the elevation or depression of the Fissure of the Hippocampi, the height to which the summit of the Curved convolution rises, and others of a similar kind put forward in the table, depends on their being indications of the greater or lesser development of certain parts of the Brain; thus, the convolutions of the Parietal lobe slant when they are pressed backwards by the increasing size of the Frontal lobe:—the Hippocampal Fissure rises high in the connection with the greater development of the Occipital lobe, or is depressed by increase in the lobes placed anteriorly to it:—the Curved convolution is beaten down by the development of the superior Bridging convolutions.

The following is Gratiolet's Classification according to Cerebral Characters:—

1 Homo.

2 Simia Satyrus (Orang-Outang, Grat.)
Hylobates (Gibbons, Grat.)
Semnopitheci (Semnopithèques, Grat.)
Cercopitheci (Guenons, Grat.)

3 Simia Troglodytes (Chimpanzé, Grat.)
Macaci (Vrais Macaques, Grat.)
Gorilla (Gorille, Grat.)

4 Cynocephali (Babouins, Grat.)
Macacus Rhesus (Macaques à queue courte, Grat.)

Catarrhini (Pithèques, Grat.).

5 [illegible]

6 [illegible]

7 [illegible]

8 [illegible]

Platyrrhini (Cébiens, Grat.).

ORGANS OF SPECIAL SENSE.

A. Organs of Touch.

There are but few examples of the special adaptation of parts for tactile exploration; such, however, may be noted in the shape of *tactile papillæ* on the fingers or tail, or on the naked terminal integument of the nose, especially when produced as a snout or proboscis; or again in the form of *vibrissæ* (that is, hairs so connected by their sclerous basal capsule and bulbs with sensory nerve filaments, as to receive very delicate impressions by contact with extraneous objects or impulse), which are commonly found on the upper or lower lips, and at the angles of the mouth: or, lastly, as expansions of highly sensitive membrane, in the shape of wings, ear-conchs, &c.

Special.

— *Tactile Papillæ.*

In *Man* the broad tips of the fingers are richly supplied with penicellate plexuses of nerves, the terminations of which occupy each the centre of a papilla.

In *Quadrumana,* tactile papillæ are developed on the fingers and on the prehensile tail (when present, *e.g.* Ateles).

In the Shrew, Mole, Elephant, Tapir, and Pig, these papillæ are specially developed on the produced exploratory snout.

— *Expansions of Membrane.*

The extent of surface and delicate organisation of the parts of the skin forming the wings and ear-conchs of those of the *Bat* tribe that

pursue volant insects, and the antennal nose-leaves of many species (Rhinolophidæ) relate to the perception of atmospheric impulses rebounding from surfaces near which the Bat approaches in flight.

B. Organ of Taste.

The Tongue is more highly developed in Mammalia than in the rest of the Vertebrata. There is occasionally found underlying the tongue a flattened process bifid at the apex, and presenting the appearance of a second tongue, this has been termed the frænal or sublingual plate. Beneath the tongue, posteriorly to the tip, is frequently found a fibrous or sclerous rudiment of the 'glosso-hyal,' called 'worm,' or '*lytta.*' The tongue is commonly divided into a free, gustative, prehensile part; and a deeper, intermolar, masticatory or deglutitional part: of these—the former may be developed to such an extent and have such mobility as to suggest the predominance of the prehensile function, or, on the contrary, may be capable of very little motion;—the latter may lack the intermolar enlargement. As a rule, in Mammalia, the vascular and sensitive lingual membrane adheres closely to the muscular tissue: occasionally its sanguine tint is obscured by pigment, and presents a leaden colour. Horny spines are sometimes found on the superior surface anteriorly, and (though very rarely) at the base, on either side the mouth.

Special.

— *Frænal Plate.*

This lingual character prevails throughout the *Strepsirrhine* group of Quadrumana.

— The *Lytta*

is well marked in the flesh-feeding *Dasyuridæ* (Marsupialia) and in the *Sectorialia.*

— The *Intermolar Enlargement*

is well marked in the *Rodentia* and *Ruminantia;*
is absent in *Quadrumana, Sectorialia,* and others.

— *Mobility.*

The *Rodentia* offer the least, and the *In-Enamellata* the greatest power of protrusion and mobility of the tongue in the whole Mammalian class.

— *Structure.*

Most *Cete* offer a marked contrast to the other Mammalia in having the skin of the tongue separated from the flesh by a layer of blubber.

— *Spines.*

In the *Felidæ* (Sectorialia), *Pteropidæ* (Cheiroptera), and especially in *Ornithorhyncus* (Monotremata), the anterior part of the tongue is covered with hard horny spines.

In the *Dugong* (Sirenia) a large but short thick retroverted horny process projects from each side of the base of the tongue.

C. Organ of Smell.

The Olfactory organ of Mammalia is seldom absent; it differs from that of other Vertebrata both in the cribriform lamina of the Ethmoid (of which the apertures transmit the branches of the first pair of nerves to the nasal cavity)—in the sinuses, subsidiary cavities usually divided into mutually communicating cells, which may exist in the frontal, sphenoid, and superior maxillary bones; and—in the great provision made by bony and gristly laminæ for the support of the olfactory membranes. It is very exceptional to find this organ wanting, but the extent of its development is very variable, especially in the matter of the accessory cavities. There is frequently* found, on each side of the cartilaginous septum of the nose, a longitudinal sac, surrounded by a cartilaginous sheath, and lined internally by a glandular mucous membrane, which communicates with a duct running through the foramina incisiva to the palate. Of the three turbinated bones, the inferior is generally most developed. In animals provided with a snout the nasal cartilages are lengthened out into a tube, which is covered with muscles that move it

* Ruminantia and Rodentia.

in many directions. Diving animals have valves*, or annular sphincter muscles†, whereby the nasal passages may be closed internally.

SPECIAL.

Olfactory Organ absent.

All *Cete* possess the 'crura rhinencephali'; but the baleen-bearing Whales alone of this Order have olfactory nerves; the family *Delphinidæ presenting the exceptional instance of the absence of the organ of smell.*

— *Cribriform plate.*

Ornithorhyncus forms the single exception in the Mammalian class to the constant presence of a cribriform plate: in this species one olfactory nerve quits each rhinencephalon and escapes from the skull by a *single* foramen; not dividing until it enters the nasal cavity.

— *Accessory cavities: Turbinated bones.*

The *Cete* have no accessory cavities in the cranial bones in connexion with the nasal cavity. In the Dolphin and Narwhal there are no turbinated bones.

D. ORGAN OF HEARING.

The Organ of Hearing is commonly formed throughout the Mammalian Class on the same general plan that it is in Man: the chief distinctive features of the Class being

1. The extension of the Cochlea into coils, suggestive of the name:

2. The ossification of the Cartilages between the stapes and tympanum, forming the 'malleus', and commonly also the 'incus': and

3. The presence, save in most swimmers and burrowers, of an external ear or conch.

It is only in the Orangs and Chimpanzees that the parts defined in the human auricle are represented: the ***Concha,*** when present, may be quite rudimental, and is sometimes represented only by a small scale-like fold of thin integument, contrasting very markedly with the trumpet-shaped

* Ornithorhyncus. † Seal.

cartilage commonly found, and with the pendulous flaps of the Elephant. The *Meatus externus* is generally osseous.

The *Tympanic cavity* is by no means always concealed in the petrous bone, as it is in Man; it is sometimes expanded into a 'bulla'; and may extend into the Squamosal and Pterygoid bones*. The tympanic bone frequently retains its freedom, and is more or less subservient to the support of the drum membrane. The Basisphenoid sometimes† enters into the formation of the tympanic cavity.

The Three *Auditory Ossicles* (Otosteals) can in general be distinguished; *viz.*, the Malleus, the Incus with the Os orbiculare, and the Stapes, although their forms undergo considerable changes. Thus, the *Malleus* occasionally bears a close resemblance to the 'cartilago columellæ' of Birds; or it may assume an expanded lamelli-form type; or be bent, completing the circle for the drum-membrane, and expanding for its attachment thereto; or, lastly, it may be perforated. Again, the *Stapes* may have a wide vacuity and slender crura, and be traversed by a bony canal surrounding the trunk of a nerve and vessel (arteria ophthalmica and maxillaris, or arteria meningea media‡) which pass through the stapes and the tympanic cavity: or it may be columelliform, its oval base supported on an imperforate stem, which may or may not develope processes marking out the Incus: or it may retain the normal Mammalian shape, and have very thick crura, by which the perforation is obliterated or reduced to a minimum.

The bony *Semicircular Canals* occasionally project from the petrosal capsule within the cranium: in many, though not in all of the Mammalia, these canals open by five orifices into the vestibule: there are nearly always three ampullæ present.

* Sloth. † In Hedgehog (Insectivora) and Marsupialia.
‡ In Cheiroptera.

Of all parts of the Labyrinth the Cochlea varies most; *viz.*, in the number of its coils, which may present all degrees of complexity, from *half* a turn to nearly *five* complete turns.

While in Man the muscles of the external ear are only feebly developed, so that it can be but slightly moved, very numerous muscles turn the Ear of the lower Mammalia in all directions. In many diving animals peculiar valve-shaped projections are found, by which the external meatus is closed and protected against the entrance of water.

Special.

1. The *Concha* is *absent* or *rudimentary*

in the *Talpidæ* (Insectivora);—in the *Phocidæ* and *Trichæcidæ* (Sectorialia Pinnigrada):—in the *Cete* (where in a full-sized Cachalot, the external opening of the ear is a longitudinal slit, one inch in length, admitting with difficulty the end of the fore-finger; and in the common Porpoise and Dolphin is so small as to require search in detecting):—in the *Sloth* (rudimental) and *Manis* (scale-like) of the In-Enamellata: and—in the *Monotremata*. (In the Echidna the external aperture presents the form of a vertical slit, shaped like the italic *S*, an inch and a half in length.)

2. *Meatus externus.*

In *Echidna* the remarkably long Meatus is strengthened by a series of incomplete cartilaginous hoops, connected together by a narrow longitudinal cartilaginous band, so that its structure closely resembles that of a trachea. The narrow tortuous meatus of *Ornithorhyncus* has a valve externally.

In the *Water Shrew* the antitragus can be brought forward so as to close the external meatus at will.

3. *Malleus.*

— *Bird-like: e.g.* Perameles (Marsupialia).

— *Lamelliform: e.g. Shrews* (Insectivora).

— *Circular: e.g.* in the *Armadillos* (In-Enamellata) where the Malleus is bent, almost, as in the *Monotremata*, completing the circle for the drum membrane.

— *Perforated: e.g.* in the Wolverine (Plantigrada; *Gulo*) and Otter

(Semiplantigrada, *Lutra*) of the Sectorialia the Malleus is perforated near the origin of the process.

4. *Stapes* and *Incus.*

— *Perforation transversed by osseous cylinder.*

In most *Insectivora* (*e.g.* Mole) part of the osseous wall of the labyrinth conducts a vessel and nerve through the opening of the Stapes.

This is also the case in many *Rodentia* (*e.g.* Squirrels, Cavies, Marmots).

— *Avian type.*

In some *Bats* (Cheiroptera), *e.g.* Vespertilio noctula, may be noted a retention of the columelliform confluence of Stapes and Incus.

In most *Marsupialia* (*e. g.* in Perameles), and *Monotremata*, the Stapes is columelliform; its base oval, supported on an *imperforate* stem; its apex being more expanded in the former than in the latter Order.

— Stapes *imperforate.*

In addition to the above-named instances; note this also in the *Walrus* (Sect. Pin.) and *Delphinus leucas* (Cete).

5. *Semicircular Canals.*

In most *Insectivora* the bony semicircular canals project from the petrosal capsule within the cranium, and conspicuously so in the Mole (Talpa), in which the petrosal is large and cellular.

All *insectivorous Cheiroptera* and *Monotremata* likewise show this same projection.

6. *Vestibule*, &c.

In the *Whales* the Vestibule of the labyrinth is all but wanting.

In the *Sloths* there are only two 'ampullæ,' none being met with upon the external canal.

7. *Cochlea*, &c.

In the *Monotremata* the Cochlea has only *a half* coil;

in *Bimana, Quadrumana, Cheiroptera, Solidungula* (Perrisso-d.), and *Ruminantia* (Artio-d.), *two and a half* coils;

in *Sectorialia three* coils;

in most *Rodentia four;* in *Cœlogenys Paca* nearly *five* coils.

E. Organ of Sight.

It is only in Man and the Apes that the eye is situated in a complete bony cavity; in all the rest of the Mammalia the Orbital fossæ are completed, and separated from the Temporal fossæ by membrane only. Eyes are always present in this Class, but they are occasionally very rudimentary, and covered by the skin, which passes over the eyeball without any palpebral opening or loss of hair. They frequently hold a lateral position, and if, when this is the case, the Cornea is also prominent, they are susceptible of receiving the image of a pursuer without turning the head.

The Eye is commonly moved by six *Muscles*, as in Man; of these, the '*Superior oblique*,' (which arises from the back part of the rim of the orbit with the Recti, advances to the upper part of the rim, glides there through a tendinous pulley, returns towards the eyeball, is reflected backward and outward beneath the Rectus superior, and is inserted into the Sclerotic between this muscle and the Rectus Externus), demands special notice inasmuch as the trochlear arrangement thereof is peculiar to the present Class.—Besides these there exists in all Quadrupeds up to the Quadrumana another muscle which runs from the margin of the Optic Foramen, surrounds the Optic nerve, and expands like a funnel as it approaches the back part of the eyeball to which it is fixed; this is termed the '*Choanoid* Muscle,' or *Suspensorius Occuli;* it is generally single, but may be bifid, or even quadrifid; and occasionally, though very rarely, is the only muscle present.—The *lower eyelid* has occasionally a special *depressor*, or apertor muscle.—And the Third eyelid a special '*nictitator*' muscle, which however has not the same arrangement as in Birds.—Lastly, an '*Orbicular*' muscle, to close the circular eyelid, may be present.

The longitudinal axis of the eye is generally of less extent

than the transverse*: but the relative size of the eyeball seems to increase directly with the increasing power of locomotion of the different species, even in those of the same Order. The eyes are generally small in those species that burrow.

In no Mammal is bone developed in the *Sclerotic;* but this investing membrane is itself occasionally 'fibro-cartilaginous', and may be present in great thickness especially round the entrance of the Optic Nerve. The *Cornea,* which generally presents a more or less convex surface externally, is flat in the Aquatic Mammalia. In all Mammalia, Monodelphous, and Didelphous, as far as at present observed, the *Lens* and *Ciliary muscle* do not differ in any essential point from those of Man. In all other Mammalia the Lens is more spherical than in Man, especially in Aquatic species: in most, the central planes are three, as in the human fœtus: in a few† there is but one. The *Capsule,* its epithelium, and the lens-fibres, are essentially like those of Man. The *Ciliary processes* are simple; the suspensory ligament and its connexions, the arrangement of the Ciliary muscle (which derives its nerves from the lenticular ganglion), and the kind of muscular tissue (*unstriped*), are such as we find in the Human eye‡. The *Pupil* is almost invariably circular, but is sometimes capable of being contracted to form a vertical slit: occasionally also the pupil is found transversely oblong, with the upper border somewhat festooned by the presence of a *Ligamentum pectinatum.*

Tuft-shaped flakes of pigment, called the *Racemiform,* or sponge-like bodies, are occasionally found projecting from the pigment layer (Uvea) at the posterior surface of the Iris, and tending to interrupt the regular margin of the Pupil.

* Except in Man and Apes.

† Cete and some Rodentia. ‡ Hulke.

Crepuscular and *Nocturnal* Mammals (*e.g.* Pteromys, Aye-Aye, Lemur) have a large convex Cornea, very wide Pupil, and convex Lens (esp. Bats and Nocturnal Rodents).—*Aquatic* Mammals, on the contrary, have an excessively convex Lens, but very slightly projecting Cornea.

In many Mammals the *Choroid,* instead of being uniformly lined with dark pigment, as in Man, presents, on a greater or less extent of its back part, a brightly coloured layer, named *Tapetum,* on the inner surface of which is the tunic of Ruysch (*i.e.* the inner part of the Choroid Coat formed by the capillaries of the Choroidal vessels), as well as the layer of hexagonal cells, which, however, is here, as in the eye of the Albino, destitute of pigment. The Tapetum consists sometimes of tendinous fibres, sometimes of cells, filled with granular matter*: it is of various colours, *e.g.* silvery, white, white edged with blue, light blue, green, amber, chocolate: it occupies a broad transverse tract of the Choroid; and may present a Crescentic form, the greater extent being below the entrance of the Optic nerve, and only a small portion above. No Tapetum is found in Bimana, nor in Quadrumana, above the Lemurs.

The *Macula lutea* of the Retina, or 'yellow spot' of Sœmmering, appears to be confined to the eye of Bimana, and of the higher Quadrumana.

The eye is occasionally closed by a single circular *Eyelid* with a small round opening in it, and protected by a cartilaginous plate continued from the upper part of the Orbit, comparable to the palpebral plates in the Crocodile: such circular eyelid may however have the division of the horizontal eyelids indicated by an external groove at the inner Canthus*. As a rule there are *three* eyelids present, two being horizontal: of these the lower one is generally the largest

* Leidig. * κανθός, the corner of the eye.

and most movable, and rarely has a proper 'depressor' muscle, but falls down by its own elasticity on the relaxation of the 'orbicularis' which draws it up. The upper eyelid is occasionally provided with cilia. The third, innermost, eyelid is vertical, and termed the membrana nictitans, it contains muscular fibres, and extends over the eye when that is drawn back by the action of the 'suspensorious' muscle; it is sometimes small, rudimentary, or absent.

The *Lachrymal Glands* are often small, and sometimes appear to be wanting. A special gland, subserving the movements of the third or nictitating eyelid, termed the *Harderian* gland, is present in all quadrupeds up to the Quadrumana, though occasionally represented merely by an aggregate of follicles, somewhat more complex than the 'Meibomian,' at the inner side of the eyeball*. The group of glandular follicles sometimes found occupying the recess of the inner canthus, and named the '*Caruncula Lachrymalis,*' are generally absent when the Membrana Nictitans is much developed, and therefore seldom coexist with the Harderian gland. In all Mammals with divided or horizontal eyelids there is found a provision for carrying off the waste lubricating fluid of the eyeball, similar to that in Man.

Special.

1. *Eye.*

— *Rudimentary*, &c.

In certain burrowing Insectivora, and Rodentia, *e.g. Chrysochloris* and *Talpa cæca* (Insectivora); *Spalax typhlus* (mole rat), *Mus typhlus* (Rodentia).

— *Situated laterally* with *prominent Cornea.*

e.g. in *Jerboidæ* and *Leporidæ* (Rodentia); and *Horse* (Perissodactyla, Solidungula).

in *Ruminantia* (Artiodactyla) the eyes are lateral.

* *e.g.* in Cete and Proboscidia.

2. ***Suspensory Muscle***

— is ***divided***

in *Cete* into *four* short muscles, paralleling the longer recti, but of greater breadth, and almost continuous.

In *Rhinoceros* (Perissodactyla, Multungula) the fasciculi of the Choanoid Muscle have coalesced into *two* masses.

— is *alone present*

in the *Balænæ* (Cete), in the absence of the other muscles of the eye*.

— is *rudimentary*

in *lower Quadrumana;* where a few fibres detached from the inner part of the origin of the recti to be inserted into the sclerotic nearer the entry of the Optic Nerve represent it.

3. 'Depressor' of lower eyelid.

In *Rhinoceros* and *Monotremata* the lower eyelid has a depressor muscle.

4. '*Nictitator*' muscle.

In *Elephas* (Proboscidia) there is a special 'nictitator' muscle, the fibres of which pass at first over the base of the membrane in a curve, then form an angle to include the extremity of the nictitating cartilage, which is consequently moved in the diagonal of the contracting forces.

5. '*Orbicular*' muscle.

In *Cete*, and *Seals* (Sectorialia) the circular palpebral opening is closed by an 'orbicular' muscle, or sphincter, and is expanded by four broad, thin, almost continuous muscles (*e.g.* Porpoise).

6. The *Sclerotic* coat.

In the *Ornithorhyncus* the 'Sclerotic' is *fibro-cartilaginous.*

In the *Cete* the Sclerotic is *excessively thick*, as also in the *Proboscidia*, at the entrance of the optic nerve.

7. The *Pupil*

— contracts to a *vertical slit*

In the *Bradypodidæ* (In-Enamellata) and the small crepuscular † Felidæ (Sectorialia).

— is *transversely oblong*

in *Camel*, *Ox*, and *Sheep*.

* Mayer. † In the large diurnal Felidæ it is circular.

8. The *Ligamentum pectinatum*

in *Man* consists of slight festoon-like processes of the fibres of the Iris, lying in a transparent elastic fibrous tissue, continuous with the posterior elastic layer of the Cornea:

in the eyes of the *Sheep* and *Ox* it is a more developed structure than in the Human eye, and in them the festooned processes are prominent, giving a milled appearance like that of the edge of a coin.

Racemiform bodies projecting from the Uvea are found in the Solidungula and Ruminantia generally.

9. The *Tapetum*

— in *colour* is

— usually *green* in Perissodactyla* (except in Horse, in which it is *light blue*); in most Artiodactyla (being, however, *chocolate* in the Hog), and in Proboscidia: but is *silvery white* in the Cete, and most Sectoralia (except in the Felidæ, in which it is *amber*, and the Canidæ, in which it is *white, edged with blue*):

— in *structure*

it consists of *tendinous fibres* in Ruminantia and Proboscidia: and of *cells filled with granular matter* in Sectorialia.

— in *form*

it is broadly *crescentic* in *Felidæ* (Sectorialia).

10. The *Retinal spot.*

Quadrumana. This spot, situated in or very near the axis of vision, exists in the *Catarrhina* as in Man: but has been found in no Lemurine (in which a minute fold or crease occupies its place).

11. The *Eyelids*

— are *single* and *circular*

in *Monotremata.*

In *Cete* the eyelids are represented by a continuous circular fold of the skin, leaving a round opening in front of the eye, with a narrow margin unprovided with eyelashes: this is also the case

in *Seals* (Sectorialia), where however an external groove indicates the division of the horizontal eyelids.

— *The upper Eyelid is provided with Cilia*

in all Ruminantia; they are especially long in Giraffe.

* It is absent in Rhinoceros.

— ***Membrana nictitans may be rudimentary or absent.***

In *Man* and the *Quadrumana,* at the inner Canthus, opposite the puncta lachrymalia, there intervenes a vertical fold of conjunctiva, the *plica semilunaris,* resting on the eye ball, which is a rudiment of the membrana nictitans.

The presence of this eyelid in the *Sirenia* distinguishes them from the Cete, in which it is absent.

12. The *Lachrymal glands.*

In the *Cete* there are no true Lachrymal glands: but in the Dolphins a ring-shaped gland behind the eyelids is present*.

— *Caruncula lachrymalis* coexists with Harderian glands in the Hog tribe and the Sheep.

* Rapp.

DISSECTIONS.

I. SHEEP'S HEART*.

PREPARATORY.—Inject with coloured size the Coronary arteries from their orifices in the sinuses at the root of the Aorta.

The only difficulty in dissecting a Sheep's heart lies in the mass of fat you have to contend with round its base (*i.e.* that portion which is directly attached to the great blood vessels). Now in order to remove the fat, do not attempt to slice it away from the outer surface; if you do, you will assuredly cut through superficial vessels (*i.e.* the coronary arteries and veins) and cut into others: but taking each portion of fat separately, carefully separate it by dissection from the subjacent tissue, and never cut across any structure until you are perfectly satisfied as to what it is.

EXAMINATION OF THE EXTERIOR.—When the fat has been cleaned away; taking the Heart in your hand you will note one half to be more easily indented than the other; this marks the area of the thin-walled *right*† *Ventricle:* the thick-walled left Ventricle occupying the larger part of the anterior surface.

* In order to see the first course of the vessels after leaving the heart, it will be well to obtain the heart and lungs *together*: as, however, we purpose tracing them when dissecting the complete specimen of a Mammal, we have described here the heart alone.

† In using the terms *right* and *left* we speak of the heart as situated in the body.

Placing the heart before you, with the apex towards you, and this right ventricle to your left, you will observe (1) a large vessel rather to the right of the median line, and arising from the base of the Heart: this is the ***Pulmonary Artery*** which conveys venous blood to the Lungs; (2) a distinct groove crossing the anterior surface of the Heart diagonally from the left centre of the base to a point a little below the middle of the right margin: this groove marks the line of the *interventricular* septum* and carries the proper nutrient vessels of the Heart, *viz.* the Coronary arteries and veins, in its channel; (3) a large vessel immediately posterior to the Pulmonary artery: this is the *Aorta* which conveys arterial blood to the body generally; (4) folded ear-like appendages at the base of each ventricle: these are the *Auricles;* and (5) a groove between the auricles and ventricles termed the *Auriculo-ventricular* Sulcus.

By the aid of the coloured injection thrown into them it will be well now to trace out the principal branches of the *Coronary Arteries.* There are normally two Coronary arteries, one arising from the left, and the other from the right sinus of Valsalva (two small internal pouches in the anterior segment of the root of the Aorta) as in Man; their distribution is, however, different: for in the Sheep the *right* Coronary Artery takes a short course in the groove between the right auricle and the ventricle, behind the cone at the base of the Pulmonary artery, and then sends off a short branch posteriorly to the auricle, its main stem continuing along the right margin of the Heart: while the *left* Coronary Artery immediately on leaving the Aorta divides into three branches†, one running along the anterior interventricular groove; the second traversing the left border of the

* *i.e.* the Septum, which separates the cavities of the two ventricles.

† As an abnormality the third branch is sometimes found commencing by a distinct orifice in the left sinus.

Heart; and the third taking a course close under the left auricle in the Auriculo-ventricular sulcus, and reaching to the back of the heart and the posterior interventricular groove.

Lastly, we may note on the exterior of the ventricles several white lines running across the superficial branches of the vessels; these are Nerves derived from the Cardiac plexuses*, which are themselves derived partly from the Cerebro-spinal and partly from the Sympathetic system†.

Turning the Heart over, the transverse groove which goes round the base of the Heart between the Auricles and Ventricles, and which is interrupted only by the trunk of the Pulmonary artery anteriorly, is readily traced: the vessel in close relation with and posterior to the Aorta, and opening into the right Auricle at its superior border, is the *Vena Cava Superior*, which conveys to the Heart the blood which is returned from the Head, Neck, Upper Limbs, and Thorax, and is remarkable as being a vein without valves: the vessel nearly in the middle line, and terminating in the right Auricle a little above its inferior margin, is the *Vena Cava Inferior*, which returns the blood from the Lower Limbs, from the Viscera, Pelvis, and Abdomen: that vessel which passes down to the side of the left Auricle immediately behind the Appendix, and continues its course along the back of the left Auricle and Auriculo-ventricular groove to reach the lower and back part of the right Auricle, on the left of the Orifice of the inferior cava, close to the interauricular septum, and below and behind the fossa ovalis (like the left superior cava in the lower Mammalia and in Birds), is the large *Left Azygos Vein*‡; it

* The *deep Cardiac plexus* is situated inferiorly to the Trachea at its bifurcation; close to the point of division of the pulmonary artery, and above the arch of the Aorta. The *superficial Cardiac Plexus* lies within the arch of the Aorta and beneath the right Pulmonary artery.

† In order to expose these more clearly, let the heart be placed in a Nitric acid and spirit bath, consisting of 6½ drs. of acid to one quart of spirit, for three or four days.—*C. Robertson.*

‡ J. Marshall.

receives all the Intercostal veins of its own side, and the lower right Intercostal veins also: its lower part is always dilated and muscular: the Coronary vein opens into it, as also a series of small veins from the back of the heart, the mouths of which are all provided with valves, while, on the contrary, no valves exist along the continuation upwards of the large venous trunk (azygos), at least in the neighbourhood of the Heart. We find then in the Sheep, as in most large Quadrupeds, a right Vena Cava Superior and a left Azygos Venous Trunk, instead of a right Vena Cava Superior and a left Cardiac Venous Trunk or Coronary Sinus as in Man. The size of the left Azygos is complementary to that of the right: hence we find the right Azygos in the Sheep is insignificant; whereas in Man, in whom the left Azygos is all but obliterated*, the right Azygos is large. A further correlation of growth may be noted, *viz.* that whereas the Thebesian valve is present in every instance in which the left venous trunk forms a 'Coronary Sinus' receiving veins from the heart alone (as in Man); it is certainly absent in those animals which have a left Azygos or left Superior Cava, being represented in the Sheep merely by a slight ridge of the Auricular Parietes. Situated superiorly to the dilated portion of the Left Azygos may be seen the cut orifices of the *Pulmonary Veins,* which return the blood from the Lungs and are without valves. Hence we see that the Auricular portion of the Heart is immediately connected with the great Veins: and the ventricular portion with the great Arterial trunks.

* The remnant of the obliterated left Azygos trunk of the Fœtus exists in the adult, as (i.) an oblique Auricular vein running in a *direct course* from the back part of the left Auricle to open into the 'Coronary Sinus,' *unprotected by any valve* at its mouth, (ii.) lines or streaks continued upwards from this vessel on the wall of the right Auricle, (iii.) a further prolongation in the shape of a small duplicature of the serous layer of the pericardium, passing between the left Pulmonary artery and the subjacent Pulmonary vein, termed by Marshall the *Vestigial Fold of the Pericardium.*

DISSECTION OF RIGHT AURICLE.—In order to examine the interior of the right Auricle it will only be necessary to make one incision, *viz.* from the point of entrance of the Vena Cava inferior to the Auricular appendage; and to remove and wash out the blood.

Around and in the interior of the Appendix are fleshy bands, named *Musculi Pectinati*, which form a net-work contrasting with the general smoothness of the Auricle. Immediately opposite the termination of the Inferior Cava is a large oval depression, *Fovea*, seu *Fossa Ovalis*, which is the vestige of the *Foramen Ovale* of the Fœtal Heart, and indicates the original place of communication between the two Auricles; it is bounded by a prominent ridge of muscular fibre called *Annulus*, seu *Isthmus Vieussenii:* a thin semitransparent structure closes the Fossa and forms the *Septum Auricularum*. In front of and beneath the Inferior Cava is a thin fold of the lining membrane of the cavity, a rudiment of the *Eustachian Valve*, a remnant of a much larger structure in the Fœtus by which the blood from the Inferior Cava was directed through the Foramen Ovale into the left Auricle. Immediately beneath the Eustachian Valve is the dilated orifice of the left Vena Azygos; at its termination and almost within the Auricle may be seen the mouths of the smaller veins of the Heart (venæ cordis minimæ) named the *Foramina Thebesii*. Between the openings of the Superior and Inferior Cava, on the right side of the wall of the Auricle is a small projection termed the *Tubercle of Lower:* it was supposed by Lower to direct the blood from the Superior Cava towards the Auriculo-ventricular opening (*i.e.* the opening between the Auricle and Ventricle). The orifice of the Superior Cava is not provided with a valve.

In the Adult there is but *one* current of blood in the right Auricle, *viz.* towards the Ventricle: but in the Fœtus there are *two* streams in the cavity of the Auricle: one of pure and the other of impure blood, which cross one another in early

life, but become more commingled as birth approaches. The Placental or pure blood, entering by the Inferior Cava, is directed by the Eustachian Valve chiefly into the left Auricle through the Foramen Ovale; while the current of the Systemic or impure blood, coming in by the Superior Cava, flows downwards in front of the other to the right ventricle*.

DISSECTION OF RIGHT VENTRICLE. To examine the interior of the right Ventricle the dissector will pass the forefinger of the left hand through the Auriculo-ventricular orifice, and make an incision with the scalpel a little to the right† of the anterior interventricular groove, from the base or origin of the Pulmonary Artery to near the apex of the Heart, and carry the incision round posteriorly a little to the right of the posterior Inter-ventricular groove up to the Auriculo-ventricular groove.

On raising the V-shaped flap thus formed, the base of the ventricular cavity will be seen to be perforated by two apertures; that on the right, leading into the Auricle, is the *right Auriculo-ventricular opening;* that on the left, and higher up, is the *Infundibulum,* or mouth of the Pulmonary Artery. That wall of the Ventricle comprised in the V-shaped flap is comparatively thin, and has its internal surface marked by projecting fleshy bands of muscular fibres, called *Columnæ Carneæ:* of these, those that project freely into the cavity and give attachment by their free ends to the little tendinous cords of the valves of the auriculo-ventricular opening are named *Musculi Papillares.* The left or inner wall of the Ventricle is much smoother, especially near the aperture of the Pulmonary Artery. A strong moderator band will be noticed passing from one wall of the Ventricle to the other; this band is generally found where the life of the animal depends upon its speed. Surrounding the Auriculo-ventricular orifice is a strong fibrous band, from which is prolonged a thin membranous

* Ellis. † See note, p. 153.

valve which projects into the cavity of the Ventricle: near its attachment to the Heart this valve is undivided, but it presents three chief points at its lower margin, and is thence named the *Tricuspid Valve;* to the free margin of this valve are attached the small tendinous cords, *Chordæ Tendineæ,* above mentioned.

During the contraction of the Ventricle the valve is raised by the blood, so as to close the opening into the Auricle; but the further protrusion of it into the auricular cavity is arrested by the small tendinous cords.

From the funnel-shaped part of the right Ventricle the pulmonary artery arises; at its mouth are seen three *Semilunar* or *Sigmoid valves:* these should be further brought to view by prolonging the incision in the anterior wall of the Ventricle upwards, into the pulmonary artery, between two of the segments of these valves. In the free margin of each valve there is seen a slightly thickened nodule called the *Corpus Arantii*; and in the wall of the artery, within each valve, and on a level with the free margin, is seen a slight hollow, called the *Sinus of Valsalva.**

When the blood is entering the artery these valves are pressed against the wall; but when the distended artery reacts upon the contained blood, the valves are thrown towards towards the centre of the cylinder and arrest the return of the blood to the Ventricle.

Dissection of Left Auricle.—A cut should be made with the scissors from the entrance of the right pair of pulmonary veins (*i.e.* just above and to the left of the fossa ovalis) to the free extremity of the Auricle.

The Musculi Pectinati, and the Auriculo-ventricular orifice will be seen to resemble those in the other Auricle: and on holding the septum between the Auricles to the light, a slight

* These are better marked in the Aorta.

indication of the superficial semi-lunar fossa (which is well marked in man), may be seen; *i.e.* the now adherent border of a membranous valve which during fœtal life is applied to the left side of the then open Foramen Ovale. The mouths of each pair of Pulmonary veins open close to one another; those from the right lung open into the extreme right of the Auricle, near the septum; those from the left lung open in both cases close to the left Vena Azygos. The Pulmonary veins are not provided with valves.

Dissection of Left Ventricle.—In order to expose the internal aspect of the left Ventricle, an incision should be made through its anterior wall, just below the Coronary artery that supplies the left side of the Heart, and to the left of the septum; and should be continued parallel with the ventricular groove round the right of the Apex to a point a little to the left of the middle line posteriorly, and then upwards until it meets the left Coronary artery at the point where it descends to run along the ventricular groove at the back of the Heart: on raising this triangular flap it will be necessary to cut across several small fibrous bands which run from the free outer wall of the Ventricle to the Inter-ventricular Septum.

The walls of this Ventricle will at once be noticed to be considerably thicker than those of the right Ventricle. Its internal surface is much marked by the projecting Columnæ Carneæ, except near the Aortic opening. The Musculi Papillares are collected for the most part into two great bundles, whence proceed the numerous Chordæ Tendineæ with which the *two* segments of the Auriculo-ventricular valve are furnished. This valve, which is called '*Mitral*' from a fancied resemblance to a Mitre, is attached both to a fibrous ring surrounding the Auriculo-ventricular aperture, and, in part, to the Aortic ring: the right segment of this valve alone intervening between the the Aortic and Auriculo-ventricular apertures. The open-

ing of the Aorta is close to the Septum Ventricularum, and is guarded by three Sigmoid valves, larger and stronger throughout than those in the Pulmonary artery: from the two anterior Sinuses of Valsava arise the Coronary arteries.

The bone of the Heart (cf. supra, Circulation) though generally present in Ruminants does not appear in the Sheep till in advanced years*: consequently is seldom found in the Heart of a Sheep killed for food.

II. SHEEP'S BRAIN.

N.B.—It will be well to place a fresh Brain in spirit for a week at least prior to commencing the dissection, in order that it may be thoroughly hardened.

EXAMINATION OF THE EXTERIOR.—The whole exterior of the Brain will be seen to be closely invested by a membrane, called the *Pia Mater*, which dips into all the sulci between the convolutions, and forms a medium in which the arteries and veins may ramify. Besides covering the exterior of the brain, this membrane sends processes into the interior, in which the vessels that supply the walls of the enclosed space can be conveyed; thus one process penetrates into the Cerebrum below the Corpus Callosum and is termed the *Velum Interpositum;* and two vascular fringes project into the fourth ventricle, known as the *choroid* plexuses of that cavity.

* *Milne Edwards. Leçons sur la Physiologie*, t. iii., p. 492, *note*, "Chez le Mouton il ne parait se former qu'à un age avancé. [Duvernoy, *Leçons d'Anatomie Comparée* de Cuvier, t. vi. p. 292. F. S. Leuckart. *Bemerkungen* (Meckel's *Deutsches Archiv.*, t. vi. p. 136).]

Looking at the *upper surface* of the Brain (*i.e.* that surface on which the convolutions chiefly appear) it will be noted that (*a*) the large lobes of the Cerebrum do not cover the posterior twisted nodule or Cerebellum, in other words the *posterior lobe of the Cerebrum of Man is absent* (*i.e.* that lobe which, in Man, rests upon the tentorium and whose extent forwards is limited by the anterior margin of the Cerebellum); (*b*) the Cerebellum does not consist of two distinct lateral lobes connected by an elevated median portion, as in Man; but, rather, the median lobe holds the chief position.

Looking at the *under surface* or base of the Brain the student should note, (*a*) the large size of the Olfactory bulbs on either side of the anterior lobes of the Cerebrum; (*b*) the very slight extent to which the so-called 'middle' lobe appears, owing to the great development of the lobe of the Hippocampus immediately internal to and underlying it; (*c*) the small size of the Pons; and (*d*) the broad Medulla Oblongata. The structures in the median area, and the nerves, will be noted after the removal of the Pia Mater.

DISSECTION OF PRINCIPAL ARTERIES.—The student should now proceed to follow out the principal trunks of the Arteries that supply the Brain with blood; *viz.* the *Vertebral* and *Internal Carotid* Arteries. It may be well to be reminded of the course of these vessels after leaving the heart.

In all Ruminants, both right and left subclavian arteries, and both 'common' carotids, arise from one arteria innominata springing from the arch of the Aorta.

Each *Vertebral* artery is generally the first branch of the Subclavian of its own side; it passes through the foramina in the transverse processes of the cervical vertebræ from the sixth forwards, and enters the Skull through the Foramen Magnum: it then passes round the medulla oblongata to blend with its fellow in a common trunk at the posterior border of the Pons: the two vertebral arteries united form

the *Basilar* artery; this vessel receiving its name from the fact of its being in close relation with the basilar process of the Occipital bone: after traversing the Pons in the median line and reaching the anterior border of the Pons, the Basilar artery divides into two terminal branches, named the *posterior Cerebral* arteries, which run in an oblique direction forwards just internal to two nerve twigs (the third pair of nerves), and then bifurcate, one branch returning in a posterior direction, the other *continuing forwards to join the internal Carotid arteries* which enter the Brain posteriorly to the Optic Commissure, *i.e.* that mass of nerve matter lying transversely, limiting, as it were, the longitudinal furrow between the Cerebral Hemispheres posteriorly.

The '*Common*' *Carotids*, after leaving the arteria innominata, divide each of them in the neighbourhood of the Thyroid cartilage into two branches, named 'external' and 'internal' carotids; of these, the former is distributed to the *external* parts of the cranium, *viz.* the head and face; the latter to the *internal* parts of the cranium. After the bifurcation of the 'common' carotid, the 'internal' branch passes ventrad of the three transverse processes of the three upper cervical vertebræ to the Carotid foramen in the lesser wing of the sphenoid, forms a plexus in the cavernous sinus just external to the sella Tursica, and, passing just within the clinoid processes, reaches the base of the Brain a little posterior to the Optic Commissure*. Immediately on their reaching the base of the Brain *the two internal Carotids are each met by a branch of the posterior Cerebral Artery*† *of its own side*; they then proceed forwards round the Optic Commissure, and bifurcate, one branch (the 'middle cerebral') running up the fissure of Sylvius (*i.e.* the depression between the anterior and middle

* When the Brain has been removed from the Skull the cut ends of the internal Carotids are sometimes so short as to require careful search.

† Proceeding from the Basilar Artery, vide supra.

lobes of the Cerebrum), but not covered (as it is in Man) by the anterior development of the middle lobe; the second branch ('*anterior Cerebral*') of each side coming into close relation in front of the Optic Commissure, and *sending off anastomosing twigs to each other* as they pursue their parallel course along either side of the base of the longitudinal fissure between the Cerebral hemispheres. These remarkable anastomoses, first between the branches of the vertebral and internal Carotid Arteries; and secondly between the anterior Cerebral Arteries inter se, constitute the *Circle of Willis*, and form a means for equalising the circulation in the brain.

REMOVAL OF MEMBRANES.—The student should now carefully remove the adherent membranes from the surface of one half* of the brain, being especially careful at the following points, *viz.* the origin of the third pair of nerves†;—the division between the Cerebrum and Cerebellum, especially the external part of that division in which the fourth nerve lies;—the lateral extremities of the Pons where is the origin of the fifth pair;—the anterior end of the Medulla adjoining the Pons, where are the origins of the seventh pair (laterally), and of the sixth pair (near the median line);—the lateral border of the Medulla oblongata for the eighth pair; and a little internal thereto for the ninth pair—and lastly, at the posterior end of the longitudinal fissure of the Cerebrum superiorly, so as not to tear away the pineal gland or velum interpositum.

In all cases it is best to *leave the membrane round the roots of the nerves*, cutting round them with the scissors: and in cleaning the fissures, to open them out with the handle of the scalpel.

This done, the following structures present themselves for notice at the *base of the Brain.*

* In order to be able to compare the two sides after removal of the membrane.

† Supra, p. 163.

Anteriorly there is the *median longitudinal fissure* between the Cerebral hemispheres; and, at some little distance within the fissure, is the anterior border of the great transverse Cerebral commissure, called the *Corpus Callosum.*

At the base of the anterior lobes of the hemispheres, are situated the *First Pair of Nerves,* termed *Olfactory,* as being the special nerves of the sense of smell: on reaching the Cribriform plate of the Ethmoid bone they expand into a bulb from which are given off numerous filaments which pass through the cribriform foramina and are distributed to the mucous membrane of the nose.

Next may be noticed the *Optic Commissure* which rests upon the Olivary process of the Sphenoid bone: the *Optic Nerves* which proceed thence and are distributed exclusively to the eye ball, have been cut away; the optic tracts which remain posterior to the commissure, and diverge laterally may be traced back into the optic thalami and corpora quadrigemina. Just within the angle of the optic tracts, immediately behind the commissure, is the *Tuber Cinereum*: this forms part of the floor of the third ventricle, and from it proceeds the Infundibulum*, through which the cavity of the third ventricle above, is continued into the remnant of the cavity that existed in the fœtus in the Pituitary body below.

Next, behind the Tuber Cinereum, is the *Single* † Corpus Albicans, formed by the anterior Crura of the Fornix, which after descending to the base of the brain are folded upon themselves before passing upwards to the Thalami optici.

The two cylindrical bundles of white matter which emerge from the anterior border of the Pons, diverge as they pass forwards, give origin from their inner margin to the 3rd pair

* When the Brain is removed from the Skull, the Infundibulum is almost always cut through, leaving only a tubular orifice: and so also the Pituitary body which was situated in the Sella Turcica of the Sphenoid bone.

† In Man there are *two* Corpora Albicantia, except at an early period of fœtal life, when they are blended together in one large mass.

of nerves (*i.e.* the chief Motor nerves of the muscles of the eyeball), and are crossed just before entering the hemispheres by the optic tracts to which they are adherent, are the *Crura Cerebri.*

Posterior to the Corpus Albicans, bounded on either side by the Crura Cerebri, and limited posteriorly by the Pons Varolii, is the *Posterior perforated space*, which forms the back part* of the floor of the third ventricle, and is perforated by numerous small orifices for the passage of blood vessels to the Thalami optici.

Winding round the outer side of either Crus from above, having origin in the upper part of the Valve of Vieussens, immediately behind the Testes, and above the Pons Varolii, will be seen the *Fourth Pair of Nerves.* They are also called the *Trochlear*† nerves, and supply the orbital surface of the superior oblique muscle of the Eye.

The broad transverse band of white fibres which forms the great transverse cerebellar commissure, and whose extremities, contracted into a thick rounded form, constitute the *middle* crura, or peduncles, of the Cerebellum, is the *Pons Varolii.* Its under surface presents a groove in the median line, in which was lodged the basilar artery; its upper surface forms part of the floor of the fourth ventricle; and from its sides, the *Fifth Pair of Nerves*, nerv. trigeminus, or *Trifacial*, take their superficial origin.

The Trifacial‡ is the largest cranial nerve, and somewhat resembles a spinal nerve in its origin by two roots, one motor, the other sensory, and in the existence of a ganglion (Gasserian) on its sensory root: it has three great divisions. The

* Cf. supra, *Tuber Cinereum.*

† The Superior Oblique Muscle in Man passes through a fibrous loop at the inner angle of the orbit before reaching the eyeball, thus as it were, passing through a pulley or trochlea, (Gr. τροχιλια) whence the name given to the nerve supplying it.

‡ Also called *Trigeminal.*

first two trunks proceed exclusively from the ganglion, and are entirely sensory, *viz.* (*a*) the *Ophthalmic*, which enters the Orbit and supplies the eyeball, the lachrymal gland, the mucous lining of the eye and nose, and the integument and muscles of the eyebrow and forehead: and (*b*) the *Superior Maxillary*, which is continued forwards to the face below the orbit, and supplies the side of nose, the lower eyelid, upper lip, and upper teeth. The third or *Inferior Maxillary* trunk receives a considerable part from the ganglion, and has associated with it also the whole of the fibres of the motor root. It therefore becomes a mixed nerve: and supplies the teeth and gums of the lower jaw, the integument of the temple and external ear, lower part of the face and lower lip, and the muscles of mastication: it also supplies the tongue with its special nerve of the sense of taste.

The enlarged anterior part of the spinal cord immediately succeeding the Pons is the *Medulla Oblongata*; it rests its inferior surface on the basilar groove of the occipital bone, and its superior surface forms the floor of the fourth ventricle. Its inferior surface, which we are now considering, is marked by a median groove in which ran a small artery, a recurrent branch of the conjoined Vertebral arteries: and, a little to the right and left of this median groove, it is marked by a second groove commencing at the Pons and bending outwards like a hook: this marks the track of the *Arciform Fibres*, within the bend of which is situated on either side an oval mass, termed the *Olivary Body*; and at the commencement of which, just behind the Pons, is situated the *Sixth Pair of Nerves*: one arising from each lateral half of the Medulla.

The Sixth Nerve (*abducens*) is distributed to the ocular surface of the External Rectus muscle of the eye.

Between the Olivary Bodies and the median groove are the '*Anterior*' *Pyramids*.

Between the Olivary body, and the Trifacial Nerve is the

origin of the ***Seventh Pair of Nerves.*** This pair of nerves consists of two portions, named respectively Portio Mollis= *Auditory*, and Portio Dura=*Facial* Nerve. The former is the special nerve of the sense of hearing, being distributed exclusively to the internal ear; the latter is the motor nerve of the face, and is situated a little nearer to the middle line than the Portio Mollis.

Immediately behind the Olivary body, a little further back than the origin of the Seventh Pair of Nerves, will be seen the superficial origin of two of the three components of the ***Eighth Pair of Nerves***, *viz.* the *Glosso-Pharyngeal* and the *Pneumogastric* or *Vagus;* the third component, *viz.* the *Spinal Accessory*, arises by several filaments from the lateral tract of the cord below the Vagus. Of these three components the *Glosso-pharyngeal* is distributed, as its name implies, to the Tongue and Pharynx, being the nerve of *sensation* to the mucous membrane of the fauces and root of the Tongue; and of *motion* to the Pharyngeal muscles. The *Pneumogastric* has a more extensive distribution than any of the other cranial nerves, passing through the neck and cavity of the Chest to the Abdomen: it is composed of *both motor and sensory* filaments: it supplies the organs of voice and respiration with motor and sensory fibres; and the Pharynx, Œsophagus, Stomach, and Heart with motor fibres. The *Spinal Accessory* consists of two parts; one, the *accessory* part to the Vagus, to whose pharyngeal and superior laryngeal branches it contributes filaments; the other the *spinal* portion, which is distributed to the Sternomastoid* and Trapezius† muscles.

* The *Sterno-mastoid* is a muscle which passes obliquely across the neck, *arises* by two distinct heads, from the Sternum and Clavicle (when present), and is *inserted* by a strong aponeurosis into the outer surface of the Mastoid process of the Temporal bone: it is a flexor and depressor of the head.

† The *Trapezius* is a muscle covering the upper and back part of the neck and shoulders; *arising* from the Occipital protuberance, ligamentum nuchæ, and spinous processes of cervical and dorsal vertebræ, and *inserted* into the upper

Posteriorly to the origin of the eighth Pair of Nerves, from the groove between the Pyramidal and Olivary bodies, the *Ninth* or *Hypoglossal* nerve takes its origin: it is the motor nerve of the Tongue.

On looking at the SUPERIOR SURFACE OF THE BRAIN, in addition to the points enumerated before, there may be seen, by slightly separating the Cerebellum from the Medulla oblongata, the triangular cavity of the *Fourth Ventricle*, the apex of which, from its resemblance to the point of a pen, is called the *Calamus Scriptorius*. On either side of the Medulla, and continuous with the 'posterior'* columns of the Cord, are the *Restiform Bodies*, which as they proceed forwards diverge from each other, assist in forming the lateral boundaries of the fourth ventricle, and then enter the corresponding hemisphere of the Cerebellum, forming its *posterior*† peduncles: in the median line is a furrow which terminates at the apex of the fourth ventricle in the *Ventricle of Arantius*, which is the remains of a canal which in the fœtus extends throughout the entire length of the Cord:—on each side of the median fissure, and separated from the Restiform bodies by a very slight groove, are two narrow white cords called the *Fasciculi* seu *Eminentia teres*. Projecting into the fourth ventricle on either side are two delicate vascular fringes, processes of the Pia Mater, called the *Choroid Plexuses of the Fourth Ventricle.*

On slightly separating the Cerebral Hemispheres, the longitudinal fissure will be seen to be floored, as it were, by the *Corpus Callosum*, a thick stratum of transverse fibres, connecting the two hemispheres of the brain, and forming the roof of a space in the interior of each hemisphere, called the Lateral Ventricle.

border of the spine of the Scapula, the Acromion, and the Clavicle: if the head is fixed it elevates the point of the shoulder; if the shoulder is fixed it draws the head more or less directly backwards.

* *i.e. Superior* in Quadruped. † Cf. *supra*, Pons Varolii.

On pressing the Cerebellum backwards so as to gain a view of the parts intervening between the Cerebrum and Cerebellum, the following structures will be disclosed. At the posterior margin of the Corpus Callosum there will be seen in the median line the posterior extremity of the *Velum Interpositum,* a vascular membrane reflected from the Pia Mater into the interior of the Brain. The Velum will be seen to pass beneath the posterior rounded border of the Corpus Callosum, and above the Corpora Quadrigemina: on slightly raising its posterior border it will be found to form an almost complete investment for a small conical reddish body, which rests upon, or rather in, the division between the anterior pair (nates) of Corpora Quadrigemina. This conical reddish body is the *Pineal Gland* (*Conarium*) so named from its peculiar shape (*pinus,* the fruit of the fir); in its base, as we shall afterwards see, is a small cavity communicating with that of the third ventricle. Posteriorly to these are the *Corpora Quadrigemina* (*optic lobes*); four rounded eminences, separated by a crucial depression; the anterior larger pair are called *Nates,* the posterior pair the *Testes*: they will be found to be situated immediately behind the third ventricle: and are seen to be connected with the Cerebellum by means of a large white cord on each side, the *processus a cerebello ad testes,* or 'superior' * peduncles of the Cerebellum; stretched between these two peduncles will be seen a thin translucent lamina of medullary substance, called the *Valve of Vieussens;* it covers-in the canal leading from the third to the fourth ventricle (*iter a tertio ad quartum ventriculum*) and forms part of the roof of the latter cavity: from the upper part of the valve, immediately behind the testes, arises the fourth or trochlear nerve, as above mentioned.

EXAMINATION OF THE INTERIOR OF THE BRAIN.

* Cf. *supra.* Restiform bodies.

1ST SECTION.—TO THE LEVEL OF THE CORPUS CALLOSUM. The Hemispheres should now be sliced off to a level with the Corpus Callosum, when the white substance of that structure will be seen connecting together both hemispheres, and marked in the middle line by a longitudinal, central, ridge, or raphe. The Student should here note the large expanse of medullary matter* now exposed, surrounded by the convoluted margin of grey substance.

2ND SECTION.—TO EXPOSE THE LATERAL VENTRICLES. In order to see the thickness of the Corpus Callosum, and to bring into view the parts in contact with its under surface, a cut should be made through that body on each side near the middle line, and continued parallel with it forwards and backwards as far as the limits of the underlying 'lateral' ventricles; the rest of the Corpus Callosum, external to the above longitudinal incisions on either side, which forms the roof of the space within, should then be removed; and inasmuch, as a part of either ventricle extends down, in the middle lobe towards the base of the Brain, the course of that cavity should be followed by incisions along each side thereof; and the superjacent substance of the hemisphere should be removed. The cavity passes at first backwards, outwards, and downwards; then curves around the Crus Cerebri, forwards and inwards, nearly to the point of the 'lobe of the Hippocampus,' close to the fissure of Sylvius.

The two large irregular cavities exposed on removal of that part of the Corpus Callosum, above described, are the *Lateral Ventricles,* serous cavities separated by the vertical Septum Lucidum; each consists of a central cavity or body, and two† smaller cavities or cornua; of these the *anterior cornu* curves forwards, outwards, and downwards in the substance of the

* The *centrum ovale majus* of Vieussens.

† Since the 'posterior' lobe of the Human Cerebrum is deficient in the Sheep, the posterior cornu is also wanting.

anterior lobe; while the *descending cornu* traverses the 'middle' lobe of the Brain, forming in its course a remarkable curve round the back of what will be shown later to be the Optic Thalamus.

The *Corpus Callosum* will be seen to present a somewhat arched form from before backwards, and to be thicker at either end than in its central part. Anteriorly it forms a bend or *genu* (of which the reflected portion is termed the *rostrum*), and is attached to the anterior cerebral lobe; posteriorly it is continuous with the fornix which immediately underlies it; and in the intermediate portion of its length it is connected with the Septum Lucidum (the vertical partition between the two lateral ventricles).

In the external wall of the anterior portion of the central cavity will be seen a pear-shaped prominence, which also forms the posterior boundary of the anterior cornu. This is the *Corpus Striatum,* so named from the striated appearance which it presents in section. The inferior border of the intraventricular portion of the Corpus Striatum is bounded by a slight depression in which lie some longitudinal fibres of white medullary substance: but these are barely traceable; however they form the *Tænia Semicircularis,* which anteriorly descends in close connection with the anterior pillar of the Fornix, and posteriorly is continued, along with the pointed end of the Corpus Striatum, into the roof of the 'descending' cornu. Beneath it is a large vein (Vena Corporis Striati), which receives numerous smaller veins from the surface of the Corpus Striatum and Thalamus Opticus, and terminates in the Vena Galeni.*

The highly vascular fringe-like membrane which comes next posteriorly, extending in a curved direction across the floor of the lateral ventricle, and following down the descend-

* *Vide infra,* in the Velum Interpositum.

ing cornu, is the *Choroid Plexus:* in front it is conjoined with the Choroid Plexus of the other side, through a large oval aperture (as it appears in this section), termed the *Foramen of Monro:* it rests upon the *Corpus Fimbriatum* or *Tænia Hippocampi,* which is a narrow white tape-like band attached along the inner border of the curved elongated eminence that extends along the entire length of the floor of the descending cornu, and is called *Hippocampus Major* or *Cornu Ammonis* (from its resemblance to a ram's horn). The Corpus Fimbriatum is a continuation of the lateral edge of the posterior pillar of the Fornix. Just anterior to the edge of the Corpus Fimbriatum, and underlying it, is a part of the eminence, called the *Optic Thalamus,* into which the Optic tracts at the base of the Brain are distinctly traceable. Running along the part of the Optic Thalamus just mentioned is seen the *Choroid Artery;* it arises either from the trunk of the internal carotid or from the middle cerebral artery, just at that point where the inferior end of the fissure of Sylvius meets the anterior end of the transverse fissure; enters the horn of the lateral ventricle, beneath the edge* of the 'middle' lobe of the Brain; and is distributed to the Hippocampus Major, Corpus Fimbriatum, and Choroid Plexus. The arteries of the Choroid Plexus, after ramifying through its substance, send branches into the substance of the Brain; the veins of the Choroid Plexuses terminate in the Venæ Galeni.

On holding up the Brain to the light, and gently raising the Corpus Callosum into its normal position, the thin semitransparent *Septum Lucidum,* which is attached above to the under surface of the Corpus Callosum, and below to the anterior part of the Fornix, is apparent. The Septum con-

* Through the same part of the transverse fissure that the Choroid artery enters the Brain, the Choroid Plexus joins with the Pia Mater.

sists of two laminæ, separated by a narrow interval, the interval being called the *Fifth Ventricle.*

3RD SECTION.—TO EXPOSE THE FIFTH VENTRICLE. The space of the very minute fifth ventricle * will come into view by cutting across the part of the Corpus Callosum that remains in the middle line; detaching the anterior half from the Septum Lucidum below, and reflecting it forwards. This ventricle is in the sheep not more than $\frac{1}{16}$-in. in length, and close within the anterior fold or genu of the Corpus Callosum.

4TH SECTION.—TO EXPOSE THE FORNIX. The posterior half of the Corpus Callosum should now be detached with care from the structures immediately subjacent to it, and reflected backwards; and the Septum Lucidum should also be removed by section along its inferior margin: by this means the *Fornix*† will be exposed, and seen to be a longitudinal lamella of fibrous matter, triangular in shape, with the apex pointing forwards: its free lateral edges (Corpora Fimbriata) forming on each side part of the floor of the lateral ventricles; and the edges of its posterior crura being in contact with the Choroid Plexuses: we have seen also that its upper surface is connected in the median line to the Septum Lucidum in front, and to the Corpus Callosum behind: lastly, at the apex it is seen arching over the Foramen of Monro at a point which will be shown later to be the front of the Optic Thalamus.

The two openings (one on each side) known as the *Foramina of Monro,* besides being the passage for the Choroid Plexus, form also a transverse communication between the lateral ventricles.

5TH SECTION.—TO EXPOSE THE UNDER SURFACE OF THE FORNIX, THE VELUM INTERPOSITUM, AND THE TRANSVERSE FISSURE OF THE CEREBRUM. The Student should now divide

* Flower. Phil. Trans., 1865, p. 638.

† Fornix, an *arch* or *Vault.*

the Fornix across anteriorly, just above the Foramen of Monro, and reflect the posterior portion backwards.

When the posterior part is raised the Fornix will be found to be supported on a vascular membrane, named *Velum Interpositum;* the apex of the *Fornix* will be seen to end in two processes, the *Anterior Crura,* separated from each other by a narrow interval, and which afterwards descend in a curved crescent form to the Corpus Albicans, where they each make a turn like half the figure 8, and furnish a white envelope to the grey matter of that body. The *Foramen of Monro* will be seen to be merely an enlarged portion of an interval that exists between the whole under surface of the body of the Fornix and subjacent structures; and the *Choroid Plexuses* will be seen to have their anterior origin from the bifurcated anterior extremity of the velum interpositum (just posterior to the anterior crura of the Fornix), and also to be connected with its lateral margins. By removing the Choroid Plexus the lateral ventricles will be seen to descend towards the middle line, where they afterwards join together and lead into the upper part of the third ventricle. The Velum Interpositum is reflected from the Pia Mater into the Interior of the Brain through the transverse fissure*, passing beneath the posterior rounded border of the Corpus Callosum and Fornix, and above the Corpora Quadrigemina, Pineal Gland, and Optic Thalami: it separates the under surface of the body of the Fornix from the cavity of the third ventricle, and its posterior border invests the Pineal Gland. The arteries of the Velum Interpositum are derived as well from the Choroid artery as from the Superior Cerebellar† Artery, which enters from behind, beneath the Corpus Callosum. Its veins, the *Venæ Galeni,*

* *Vide infra,* p. 176.

† The *Superior Cerebellar Arteries* arise near the termination of the Basilar artery: they wind round the Crus Cerebri, close to the fourth nerve, and in addition to supplying the Pia Mater covering the Cerebellum, also give several branches to the Pineal Gland and Velum Interpositum.

two in number, run along its under surface, beginning at the Foramen of Monro by the union of branches from the Venæ Corporis Striati and Venæ Plexus Choroides (noted above). The Venæ Galeni unite posteriorly in a single trunk, which terminates in the 'Straight'* sinus.

On separating the Corpus Fimbriatum from the Thalamus Opticus, the position and boundaries of the great cleft at the posterior part of the Brain, called the *Transverse Fissure,* will be readily comprehended. This fissure is situated beneath the Fornix, extending downwards, on each side, from the Foramen of Monro in the middle line to the end of the descending cornu; its central part lies beneath the Fornix and Corpus Callosum, and its lateral part is placed between the edge of the Fornix, the Optic Thalamus, and Crus Cerebri. Through this great slit, as above noted, the Pia Mater passes into the Brain, and forms the Velum Interpositum and Choroid Plexus.

6TH SECTION.—TO EXPOSE THE THALAMI OPTICI AND THIRD VENTRICLE. The Velum Interpositum should now be raised and removed; the Hippocampus Major of one side dissected away from subjacent structures and folded over on the other side; and the adjacent portions of Pia Mater removed: in doing so the student must be especially careful at the posterior border of the Velum, where it invests the Pineal gland, so as to leave that gland in situ.

On the under surface of the Velum Interpositum will be noted two very short vascular fringes projecting into a narrow oblong fissure which lies beneath and extends to the base of the Brain called the *Third Ventricle*; these are termed the

* The '*Straight*' *Sinus, i.e.* that which runs along the line of *junction* of the Falx Cerebri (*i.e.* the process of *dura mater*, which descends vertically in the longitudinal fissure between the two hemispheres of the Cerebrum) with the Tentorium (*i.e.* a horizontal process of dura mater between the Cerebrum and Cerebellum), from the termination of the inferior longitudinal sinus (which is contained in the lower *free* margin of the Falx Cerebri) back to the torcular Herophili (or point where the longitudinal and lateral sinuses are confluent).

Choroid Plexuses of the *Third Ventricle,* and resemble the like parts in the lateral ventricles. On either side of this Third Ventricle are the Optic Thalami; in front are the anterior Crura of the Fornix, with the anterior Commissure of the Cerebrum, lying in front of them and visible in the interval between them; behind is the Pineal Gland, and in front of, and beneath it, the Posterior Commissure; crossing the centre of the space from one Optic Thalamus to the other is the Middle or Soft Commissure.

The Third Ventricle communicates with the other ventricles of the Brain in the following way:—In front it joins each lateral ventricle through the Foramen of Monro: and behind, by a passage which is called the aqueduct of Sylvius, beneath the posterior commissure, it joins the fourth ventricle. At the lower part in front there is a deep pit, which leads downwards to the funnel-shaped cavity of the infundibulum (*iter ad infundibulum*).

It has been shewn that the *Thalami Optici* enter into the lateral boundaries of both the lateral and third ventricles, that they are separated from the Corpora Striata by the groove in which is the Tænia Semicircularis, and are partly covered by the Fornix: it will now be noted that along the upper part of their inner borders lie the peduncles of the Pineal Gland. The optic tracts which have already been referred to in connection with the base of the Cerebrum may be traced back to the Thalami: each tract, somewhat cylindrical towards the Optic Commissure, becomes flattened and broader as it approaches the Thalamus, and makes a bend as it turns round the Crus Cerebri to reach the back part of that body. Near this bend (which is called the *Genu* or knee), and to the outer side of the Corpora Quadrigemina are placed two small, oblong, and flattened eminences connected with the posterior extremity of the Optic tract: these are called the *Corpora Geniculata.*

The four rounded eminences placed in pairs, and situated

immediately behind the third ventricle and posterior commissure, beneath the posterior border of the Corpus Callosum and above the 'iter a tertio ad quartum ventriculum,' are the Corpora Quadrigemina. Each pair will be seen to be situated on the cerebral aspect of the peduncle of the Cerebrum of the same side: the anterior eminences (*nates*) far exceeding the posterior (*testes*) in size; and from each a lateral white band (*brachia*) proceeding beneath the Corpus Geniculatum internum to join the Optic tract. These bodies are also connected with the Cerebellum by means of a large white cord on each side, the *Processus a Cerebello ad Testes,* or superior peduncles of the Cerebellum: the thin white layer between these peduncles, the *Valve of Vieussens,* covers in the canal leading from the third to the fourth Ventricle, and gives origin to the fourth nerve.

To Expose the Iter a Tertio ad Quartum Ventriculum, Fourth Ventricle, Arbor Vitæ of Cerebellum, &c. —The student should now make a vertical median incision through the whole length of the Brain, down to, but not quite dividing, the base.

By this means he will obtain a longitudinal section disclosing the following points from the front: the thickened genu and rostrum of the Corpus Callosum; the anterior extremity of the Fornix and the anterior Cerebral Commissure (very small) in close relation; the crescent of the third Ventricle, the anterior arm descending to the infundibulum, the bend passing beneath the middle or soft commissure (very large), the posterior arm ascending to the Pineal Gland; the floor of the third ventricle formed by the Optic Commissure, Infundibulum, and Corpus Albicans: from the middle of the ascending arm and proceeding backwards above the Crus Cerebri, and just beneath the posterior Commissure (which is itself just beneath the Pineal Gland) and the Corpora Quadrigemina is the 'Iter': further back, the 'Iter' is y the

upper surface of the Pons, roofed in by the Valve of Vieussens, and then passing into the fourth Ventricle beneath the Cerebellum, to terminate at the Calamus Scriptorius and Valve of Arantius, the anterior extremity of the closed central canal of the spinal cord. In the Cerebellum there will be noted the absence of any enclosed cavity or ventricle, such as was found in the Cerebrum; but, instead, the presence of a mass of white matter in the centre which sends out spreading and gradually thinning layers into the interior of all the laminæ of the grey substance which forms a continuous covering on the surface; and, as the consequence of this arrangement of the grey and white substances, the presence of a beautiful foliation or arborescence, named 'Arbor vitæ;' the section, above made, crossing the laminæ and dividing the grey and white substances together.

III. DISSECTION OF A MAMMAL.

COMMON RAT—Mus Decumanus.

Rodentia. Muridæ.

Introductory.—*Mus Decumanus* (Pallas), the Brown Rat, Le Surmulot (Buffon) of the French, is supposed to have penetrated into Western Europe from Persia and the East Indies, where it lives in burrows, about 1730; for it was not till 1727* that, after an earthquake, it arrived at Astracan by swimming across the Volga. Though frequently styled the Norway Rat, it was not known to exist in Scandinavia † when the name was first applied to it. It is somewhat larger than the Black Rat (Mus Rattus), which also originally came from the East; and has in many countries expelled it.

It is of a brownish grey colour above, and a whitish grey colour beneath. The Tail is furnished with annulate scales, and hairs between each ring, but is on the whole thinly haired and shorter than the head and body, by both of which points it may be further distinguished from the Black Rat. The Ears are rounded, somewhat naked, and exsert. The Eyes are lateral. The upper Lip is distinctly cleft: the Muffle is slightly hairy but not divided by any vertical groove ‡ separating the nostrils, the only indication of which is a small seam immediately above the incisors. The external nasal apertures, underneath the muffle, are lateral, and shaped somewhat like a comma. The Fore-feet are furnished with four toes, and on the sole are several warts, one being especially developed for

* Cuvier. Buffon, viii., p. 206. † Pennant.

‡ Waterhouse says, " A distinctly cleft upper lip, combined with a small naked muffle, divided by a vertical groove, and separating the nostrils, is characteristic of nearly the whole of the Great Murine and Sciurine sections" (Nat. Hist. Mam. vol. ii., p. 7); but this does not appear to be so here.

the thumb, and unguiculate. The Hind-feet are pentadactyle. The Incisor teeth are two in number in each jaw, large, incurved, and separated from the Molars by an interval or diastema, the result of the withdrawal of the Canines: their depth is greater than their width, and their sides are somewhat flattened.

The creature before us bears the following external characteristics of a VERTEBRATE: its body seems bilaterally symmetrical, and presents no appearance of segmentation; it has not more than two pairs of limbs; its jaws appear to be modifications of the walls of the head rather than modifications of limbs; the organs of smell, sight, and hearing, are limited to the head, and consist of single bilaterally symmetrical pairs; lastly, it is possessed of an anus,—no Vertebrate being aproctous.

It bears the following characteristics of a *MAMMAL*, *viz.*: the covering of hair; the vibrissæ on the snout; the under-jaw alone moveable; the external ear; the cartilaginous prolongation of the bony parts of the nasal cavity, forming a nose, or muzzle: and the intromittent organ of generation.

It would be placed with the RODENTIA, as being possessed of two *scalpriform* Incisors in each jaw, and having these separated by a diastema from the molars, *i.e.* lacking Canine teeth: and from its scaly thinly-haired tail, it would be grouped with the *Muridæ*.

INJECTION.—The animal is best injected from the jugular vein, which may be readily found by first making a straight incision through the skin, about an inch long, from the end of the sternum to the symphysis of the jaw, and reflecting the the skin on one side; and then with the scalpel making a slight incision through the muscle underlying the skin; when the vein will be found holding an antero-posterior course across the clavide about half way between the middle of the chest and the anterior border of the shoulder. A

slight incision should be made into the vein; the pipe of the injecting syringe inserted into the incision then made pointed towards the body, and a ligature passed round the vein enclosing the pipe.

We may conveniently divide the course of the dissection into two parts.

I. Abdominal region. II. Thoracic region.

The dissection of the Head will be more conveniently treated of in a larger subject.*

N.B. *The student should have the skeleton of a Rat before him.*

The animal should be laid upon its back on a cork of sufficient width to allow of the limbs being pinned out on either side, by which means the body may be kept firmly in position.

Removal of the Skin. To raise the skin from the ventral aspect of the body one longitudinal cut should be made, *severing the skin only,* in the middle line, the entire length of the body, and the skin should be reflected to either side.

Abdominal Muscles. After removing the skin, the first muscle which presents itself, and which adheres very closely to the skin, is peculiar to Quadrupeds, *viz.*, the *Panniculus Carnosus*, or Musculus Subcutaneus. This fleshy pannicle is spread over the whole body; the abdominal portion forms a broad expansion, its fibres running from the shoulder to the flank; on the supero-lateral area of the abdomen it is thick and fleshy, especially behind the arm, below which it sends a tendinous expansion which penetrates between the caput muscles and the chest, and gets attached to the Pectoralis Major and internal trochanter of the Humerus. It is *related* externally with the skin; internally with abdominal tunic and muscles: its *action* is to corrugate the skin, bind down other muscles, and assist in difficult expiration.

This *Panniculus* should be removed, and there will then be apparent a thin white median line, extending from the ster-

* Vide Dissection IV., *Sheep's Head.*

num, posteriorly, the whole length of the abdomen. This is the fibrous cord called *Linea Alba;* about midway in its length is an enlarged white spot, which is the remains of the Umbilicus. Situated on either side of, and attached to the Linea Alba, on the inferior and middle part of the abdomen are the *Recti* (*s.* Sterno-pubiales) muscles, bounded superficially by a tendinous aponeurosis.

External to the Recti Muscles on either side is a white line, marking both the outer edge of these muscles and the union of the fleshy and aponeurotic portions of the pair of muscles that together occupy the whole area of the abdomen, *viz.*, the *External Oblique* (*s.* Costo-abdominalis) muscles. The External Oblique may be traced upwards to its *origin* by fleshy processes from the outer surface of several of the posterior ribs; and the alternation of these processes with similar processes which form the origin of the Serratus Magnus* muscle beneath the arm should be noted.

From the front of the Sternum there arises the *Pectoralis Major* muscle, triangular in shape, with the base at the Thorax, and the apex at the Arm, where it is inserted into the Humerus.

The External Oblique muscle should be now raised,—by carrying the scalpel through the digitations near the ribs, continuing the incision along the side, and reflecting it towards the middle of the body,—in order to expose (*a*) the Ribs and the Intercostal Muscles which lie just within its anterior fibres; and (*b*) the Internal Oblique muscle posteriorly. In raising it care must be taken not to detach the Rectus muscle from the Ribs above, and to avoid cutting through the tendon of the Internal Oblique at the upper part, towards the sternum.

The *Internal Oblique* muscle (*s.* Ilio-abdominalis) *rises* from the crest of the Ilium, and its fibres have a general oblique direction forwards towards the middle line; it is *in-*

* The *Serratus Magnus* arises by pointed processes from the ribs, and is inserted into the Scapula.

serted into the inner surface of the cartilage of all the false ribs, the symphysis pubis, and the linea alba.

Cavity of Abdomen. *The cavity of the abdomen is now to be opened,* by a longitudinal cut with the scissors from the Ensiform Cartilage at the end of the Sternum to the Pelvis, through the conjoined aponeuroses of the muscles of the abdomen; followed by a lateral incision on each side along the edge of the posterior ribs; care being taken not to pierce or prick any of the subjacent organs or their surroundings. The flaps thus marked out should be reflected to either side.

On first opening the Abdomen the glistening appearance of the peritoneum or lining membrane of the cavity should be noted: and before the natural position of the viscera is disturbed, their general arrangement and connection with surrounding parts should be examined: which will be found to be much as follows, slight variations occurring according to the season of the year and the gender of the species on which the dissection is made.

Extending across the whole of the anterior moiety of the abdomen is the Liver, in part concealed by the ribs; as many as four lobes present themselves. On the left side a piece of the Stomach is visible, but this viscus is to a considerable extent hidden by the Liver. In the median line a deep red body above an inch in length is seen, lying in a transverse direction, slightly hidden in the centre by the Liver: this is the Spleen. At the left end of the Spleen, and between it and the Stomach, is situated the Kidney. Continuing in the middle line, we come next posteriorly to the small intestines, coiled about the whole of the posterior moiety of the Abdominal cavity: and almost adjoining the Spleen, separated therefrom by a coil of small Intestine, are the Large Intestine and Cæcum, both of a greyish colour; the Cæcum being generally rather to the animal's right, but free and not bound down to the right iliac fossa, as is the case in Man.

The specimen before us being a male, we come next to the small whitish bladder in the middle line, and on either side of it the pinkish tinted Cowper's Glands, external to which again are the vesiculæ seminales: and lastly in the median line the Penis and Scrotum.

On gently pressing away the Liver from the cavity it occupies anteriorly, two structures will be apparent:—first, the *Diaphragm,* which forms a vaulted moveable partition between the Thorax and the Abdomen, and which, by its movement up and down alternately, during respiration, causes enlargement of the Thoracic cavity in inspiration, and of the Abdominal cavity in expiration; and, concomitantly, a slight alteration in the position of certain of the Abdominal Viscera, especially the Liver, Stomach, and Spleen;—secondly, in the middle, a reflection of the Peritoneal lining between the Liver and the Diaphragm forming one of the *suspensory ligaments* of the Liver.

On raising the posterior free border of the Liver, the whole of the *Stomach* is apparent: the left or cardiac portion of this viscus is ovate and strongly recurved; the Œsophagus will be readily seen to enter near the middle of the anterior or concave border, immediately to the right of which the Stomach will be seen to assume a different hue, marking the commencement of the right or pyloric portion whose parietes are thicker than those of the cardiac, and are glandular internally: the Pyloric stricture should also be noted, and the small tendinous spot immediately preceding it, at the end of the pyloric portion of the Stomach whence a ligament proceeds to be attached to the abdominal surface of the large left lobe of the Liver.

On turning forwards the Stomach, and at the same time gently pulling the Spleen away, the diffused *Pancreas** comes into view, spread throughout the *Omentum* (a process of peritoneum found only in Mammals), which is attached to the postero-superior segment of the Stomach, and to the Spleen.

* Cf. p. 187.

The Pancreas may be distinguished from the fat by its rather fleshy hue.

The Large Intestine, which is often of a greenish colour, should now be turned down towards the tail, disclosing the short simple Cæcum about an inch in length,—the termination of the small Intestine thereat in the shape of a white cord-like tube about $\frac{1}{8}$-*in.* in diameter, coming down rather from the left side, and—the commencement of the large Intestine as a greenish tube of larger calibre. The large Intestine may be traced further by moving the small intestines to the left of the animal; and be seen to continue up the right side, and then straight across the body to the middle line, at which point it assumes an antero-posterior direction. By turning the Intestines over to the right, the last section is seen to contract abruptly about $1\frac{1}{2}$-*in.* from the anus to which it proceeds as 'rectum' in a direct antero-posterior line. The size of the Intestinal canal of the Rodent varies directly as the teeth. It is largest in those species which have rootless molars, but is of moderate size, and is more simple in form in those species, as the Rat before us, which subsist less exclusively upon vegetable substances, and have rooted tubercular molars.

As noted above, it will be now distinctly seen that the Large Intestine (excepting Rectum) and Cæcum are not kept in place nor connected to the abdominal walls by folds of Peritoneum, as is the case in Man, but are free, and not bound down.

The Student should now turn over and spread out all across the body, away from the Liver, the whole of the small intestines, taking each coil separately, and placing them in order, without tearing them, or injuring any structures in connection with them. By this means he will be enabled to see the whole of the *Mesentery** supporting the Small Intestines, together with the Mesenteric vessels, and the aggregation of Mesenteric glands, which form a knotted dark-coloured band, in the

* μεσος, middle; ἐντερον, intestine.

centre of the Membrane. Next, let him turn over the Intestines on the right of the body, and trace the first three inches of the Small Intestine after leaving the Pylorus, laying it out on the left, towards the tail; by this means a light white cord is seen, to the right, which would seem to prevent the complete extension of the Intestine in the direction indicated, and which appears to issue from the right centre of the dorsal margin of the Liver. The white cord is the *Bile duct,* which enters the Intestine about two inches from the Pylorus. Between the Bile duct and the Intestine is stretched a process of Omentum in which a further portion of the diffused *Pancreas* is visible. This low dendritic type of gland prevails in Rodentia: here the main part of the gland is that which extends from the end of the duodenal fold to the left, into the gastro-splenic omentum, where it ramifies: the chief part of the duodenal Pancreas following the curve of the gut, but ramifying in its wide mesentery. In these creatures the Pancreatic ducts are many in number, and paired; not single, as is usually the case in Man. This may be readily demonstrated by means of injection. Having tied one end of the Hepatic duct, inject a cold blue injection into the other end, and it will run, on either side, into the many Pancreatic ducts. If this last portion of Intestine, Pancreas, and Bile-duct, be now turned over to the right front, the spleen remaining as it was left above, *viz.,* over the left thigh, a little way from the stomach, the student will be able to trace the principal *factors of the Portal vein, viz.:* the Splenic coming from the Spleen, the Mesenteric vein coming across from the centre of the Mesentery, and both uniting at a spot in the median line prior to entering the substance of the Liver just dorsad of the Bile-duct.

The *Mesenteric Arteries* (which supply the Intestines, and arise from the Aorta just posterior to the Liver) and also the *Renal Arteries* may be next traced. This will be best

achieved by—first, following out the *left* renal or emulgent vein from the point at which it emerges at the hilus of the kidney to its junction with the Vena Cava on the right side, being a vein of considerable size, longer than the right rena vein, and passing ventrad of the aorta; and then carefully dissecting through the Peritoneum a little in advance of the Renal Vein, when the course of the right Renal artery will be found from the Hilus of the Kidney to its origin from a longitudinal vessel in the median line, *i.e.*, the Aorta: and close to this point, but slightly in advance of it, and on the right side, will be seen the commencement of the Mesenteric Artery.

The intervening space between these two aortic branches gives the site of the *Solar* or Epigastric *Plexus*, that is a plexus of nerves, offsets of a reddish ganglion, near the side of the Aortic trunk. Mixed up with the nerves of this plexus are numerous small lacteal glands*, and a dense tissue, which require to be moved with care.

In the Abdomen *the Aorta* will be noted to be in the median line, dorsad of all the viscera, just ventrad of the centre of the vertebræ, and with the Vena Cava to its right side, except at its point of bifurcation to form the two common iliac arteries, where the Vena Cava will be found to be exactly dorsad of the Aorta.

The *Vena Cava*, which lies to the right, and partially dorsad of the Aorta, may be followed forward as far as the posterior border of the Liver, where it disappears; and backward to its origin at the junction of the two common† iliac veins.

By pulling the lobes of the Liver forward from within the vault of the Diaphragm on the left side, and dividing the ligaments by which they are attached to it, a clear view

* A deeper extension of the Mesenteric Glands.

† The *common* Iliac Vein is formed by the confluence of and internal Iliac Veins.

may be obtained of (*a*) the *Œsophagus*, from the point where it perforates the Diaphragm up to its arrival on the anterior concave margin of the stomach; and of (*b*) the white line of the *Pneumogastric nerve* closely adherent to the dorsal segment of the circumference of the Œsophagus.

To the right of the Œsophagus will be seen the anterior abdominal portion of the Vena Cava, after it has left its hiding-place in the Liver notch, and at the point where it receives the many large branches of the hepatic veins, these veins being in greater numbers here than in Man, on account of the less degree of concentration of the lobes of the Liver.—And, lastly, to the left of the Œsophagus, and nearer to the back-bone, after a little careful dissection, will be seen the Aorta.

REMOVAL OF STOMACH, SPLEEN, PANCREAS and INTESTINES. Let a double ligature be now placed around the Œsophagus, near to its entrance into the Stomach; and a second double ligature round the rectum about an inch from the anus; and let the intestinal tube be cut through with the scissors between the ligatures at these two points; and the detached piece be taken away by cutting through the vessels and other connections which would retain it in the abdominal cavity; leàving the bile-duct about an inch long from the liver. The right Kidney is thus exposed a very little further forward in the body than the left. The smooth external surface of the Kidneys should be noted, as characteristic of the class Mammalia.

The more minute examination of the Intestines should be now proceeded with, in two portions; by cutting through the small intestine beyond the entrance of the Bile and Pancreatic ducts.

First note the form of the *Stomach*; the pyloric portion being more glandular and highly vascular than the cardiac; the Œsophagus entering the middle of the upper curvature;

the rudiment of a circular tendon, developed on its pyloric division*; and the Omentum, attached to its convex border: also the diffused fleshy-coloured Pancreas, with its ducts; the relatively large size of the Spleen; and the Bile duct.

The Stomach should now be pinned out on a cork, under water, and a window should be made in one side of it in order to expose the interior arrangement as much as possible in situ.

The Student will then note the dense white Epithelium of the cardiac half of the *Stomach,* projecting with a smooth outline into the pyloric half, and easily separable from the outer coating of the Stomach: also the extreme vascularity of the pyloric portion, and the patches of gastric glands specially visible in that part, immediately opposite as well as near to the entrance of the Œsophagus: this vascular coat terminating equally abruptly with the epithelial coat of the cardiac portion just beyond the œsophageal opening. If the Œsophagus and Pylorus be now slit down, the extra-muscular development around each will be noted, especially around the former; while the villous appearance at the commencement of the small intestine contrasts markedly with the smooth or pitted appearance of the mucous membrane of the pyloric portion of the Stomach. A small piece should be teazed up and placed under the microscope, by which means the membrane may be seen to be formed almost entirely of minute vertical tubes, which lie side by side.

The exit of the vessels of the *Spleen* along one regular line should be noted; and, in section, the network of fibrous or trabecular tissue, of which the mass is formed. No duct exists in connection with the organ.

The first inch and a-half of the small Intestine should be slit down along the line of attachment of the mesentery: a

* A bird-like characteristic.

bristle passed into the 'common' duct from its opening into the Intestine; and the villous coating noted, a small portion being placed under a low power of the microscope.

The student should next direct his attention to the division of large and small Intestines, marked by the presence of the *Cæcum*, or head of the colon (*caput cæcum coli*) *viz.* the rounded pouch-like projection of the large Intestine, which receives, at about an inch from its blind extremity, the termination of the small Intestine. The Cæcum should be cut open by making a window in the side opposite the entrance of the small Intestine, and making two incisions,—one along the attached border of small Intestine to meet this aperture; and the other, opening the large Intestine, towards the same direction. The absence of internal septa, dividing it into cells*, so commonly found in Rodents† will be noted; as also, on the contrary, its simple form and moderate size, which appears to be correllated in this Order, with rooted tubercular molars, and a non-exclusive vegetable diet. The Cæcum is bounded towards the small Intestines by a tumid white ring, representing the ileocæcal valve, close to which is the commencement of the large Intestine marked by longitudinal rugæ and the absence of villi; the calibre of the large Intestine is about half that of the Cæcum. The longitudinal rugæ do not extend beyond three inches from the Pylorus; after which the Intestine becomes both thinner and even-surfaced, except a slight pucker here and there where a bend occurs.

Portions of the Small Intestine above the Cæcum (for Peyer's glands); of the Cæcum itself; and of the Large Intestine, one piece taken near to the Cæcum, and another near to the Rectum, should be put under the microscope, in order to see well the difference of the mucous lining.

The Intestines should now be separated from the mesentery,

* *e.g.* The *spiral membrame* found in the Hare; or the *honeycomb arrangement of the walls* found in other species.

† Waterhouse.

and the length taken, both by a tape, and relatively to the body, from snout to anus. The whole length will measure *seven times that of the body*, and, of this, one-seventh will be Large Intestine: or, in inches, the whole will measure from 47 to 50 inches, the large intestine and rectum 6 to 7 inches, and the small intestine 41 to 43 inches; the Cæcum measuring from 1¼ to 2 inches.

The *Bile duct*, which was left about one inch long from the Liver, should next be traced up to that organ and the several branches into which it breaks up, agreeably to the many lobes of the multifid liver, noted. The absence of the gall bladder in this species should also be noted: the anterior lobe of the Liver (*i.e.*, the lobe immediately in apposition with the Diaphragm), corresponding to the "cystic" lobe in Man, being here notched only for the suspensory ligament. The lobe immediately posterior to the cystic lobe and extending mainly to the left is the "left lobe"; while the numerous lobes to the right of, and forming the posterior section of the organ are homologous with the "right lobe" of the human Liver. This follows the usual rule in the Multifid Liver, *viz.*: that the cystic, suspensory, or middle lobe is the largest: the portion of the gland to the right of this lobe being subdivided into two or more lobules, of which the extreme right may be the larger, and marked on its posterior aspect by a depression for the kidney; and that portion to the left more commonly remaining as a single lobe.

The *Hepatic artery* is readily seen coming from the Aorta about a quarter of an inch posterior to the Diaphragm: and within half an inch of this, farther back, may be seen the great trunk of the Inferior Cava (or Post-caval of *Owen*), crossing just ventrad of the anterior extremity of the right Kidney to pass through the accumulated attachments of the right lobes of the Liver, and through a groove in the middle or cystic lobe prior to piercing the Diaphragm.

Removal of Liver.—The Liver should be now removed from the Abdomen by cutting across the remaining ligaments, and the vena cava (leaving it as long as possible, so as to be easily distinguishable after removal of the Liver).

The general structure of the Liver should be examined under the microscope, sections being made in various directions, to expose the lobular arrangement with the intervening interlobular veins, and the intralobular radicles; the specimen before us having been injected from the jugular vein, will have the hepatic veins coloured by the injection*.

The *Kidney* may be next removed for examination, by dividing its vessels about the middle: at the anterior extremity and rather underlying it is the supra-renal body, much resembling the surrounding fat. The Ureter and the Renal vein and artery lie close together in the longitudinal fissure, or hilum, that marks the inner excavated border. Opposite the fissure is a hollow in the interior of the Kidney, called a sinus, into which the hilum leads.

In order to see the interior, it will be necessary to cut through the Kidney, from its concave to its convex border, a little to the side of the vessels, and then to slit up the latter. The section of the Kidney presents the typical Mammalian arrangement, *viz.:* an external, granular, or cortical part, and an internal, pyramidal, or medullary part; but differs from that in Man in that there is but a single papilla into which all the renal tubuli open. The investigation of the secreting tubes, &c., must be conducted with specially injected specimens of this organ; and is not easily conducted with the Kidney of a small animal as that before us.

Returning again to the body of the animal, the student should *trace back the Ureter* from the Kidney left in situ. Of the three vessels in the hilum, that which is anterior is

* In order to expose the persistent companionship of the vena porta, hepatic artery, and hepatic duct, the liver must be specially injected and hardened. *Vide Introduction.*

the renal artery; next comes the renal vein, and posteriorly, of a rather dark color, is the Ureter. This tube, by which the fluid secreted in the Kidney is conveyed to the bladder, is directed obliquely backwards and inwards towards the middle line along the dorsal wall of the abdomen, and passes ventrad of the common iliac artery of that side, and of the anterior crural nerve which meets it at that point. A slight incision should be made into the ureter close to the Kidney, and a bristle passed along it. A probe should be passed up the Rectum; the sudden contraction of the last inch of the Intestine noted; and also the relative position of the anus.

IN EXAMINATION OF THE DIAPHRAGM*, the Student should note this muscle to be made up of a central tendinous (or aponeurotic) part, and a fleshy periphery. The fleshy portion takes its *origin* from the cartilages of all the false ribs and of the last true rib, and from the superior (internal) surface of the ensiform cartilage: its fibres converge towards the centre; and it is *inserted* between the ribs and the spine. In the centre, close to the right of the tendinous part, is an opening, foramen dextrum, through which passes the inferior vena cava: to the left of the middle line, near the foramen dextrum, is a second opening, foramen sinistrum, for the passage of the œsophagus and pneumo-gastric nerves: close up to the vertebral column, ventrad of which the course of the aorta has been already noted, are two large muscular processes, of which the right is the longest and largest, termed the crura or pillars of the Diaphragm, forming an inverted arch beneath the aorta; this arch is known as the hiatus aorticus, and through it the thoracic duct passes, as well as the aorta.

DISSECTION OF THE THORAX.—The Pectoral muscles over the chest must now be carefully cleaned away and reflected on each side. First, let the skin be severed and reflected along the arm; secondly, let the Pannieulus Carnosus be reflected

* διαφρασσω, to separate two parts.

outwards; next, let the Pectoralis major be detached by dividing the muscle along its attachment to the Clavicle (but being very careful not to injure the injected jugular vein which will be seen to pass superficial to the Clavicle) and by making a vertical incision through its substance a little external to its line of attachment to the sternum and costal cartilages. This muscle should then be reflected outwards, and its tendon, attached to the Humerus, carefully examined. By this means the Pectoralis minor, situated at the upper part of the Thorax immediately beneath the Pectoralis major, will be exposed, *arising* from near the cartilages of the anterior ribs, and *inserted* into the Coracoid process of the Scapula. The costal attachment of the Pectoralis minor should be divided across, and the muscle reflected outwards, by which means the axillary vessels and nerves are brought fully into view, and should be next examined.

In the *Axilla,* or space between the upper and lateral parts of the chest, and inner side of the arm, are contained the axillary vessels and the brachial plexus, with their branches. This cavity is filled with a good deal of areolar tissue, which must be carefully removed, and the vessels and nerves cleaned from the clavicle to the elbow. The chief vessel crossing the outer portion of the space is the axillary vein; close to this is the (white) median nerve, and just internal to these is the axillary artery; the axillary vein always being on the Thoracic side of the artery, and of greater calibre. The Biceps muscle, which extends from the Scapula to the Radius, fills up the rest of the outer space. A bristle should be passed up the artery for further investigation later on. The *axillary vein* bringing the blood up from the fingers terminates about a quarter of an inch posteriorly to the Clavicle, and becomes the *subclavian vein.* The *axillary artery* is the continuation of the subclavian artery, which comes from the Arteria innominata on the right side; but direct from the

Aortic arch on the left side. The ***median nerve***, so called from the course it takes along the middle line of the arm to the hand, arises by two roots from the Brachial Plexus, which the student should now trace up, being very careful not to injure any of the injected vessels. We may here give a caution which should in every case be observed, namely, always to ***work with the scalpel along the line of direction of a vessel or nerve***, and never across it. The *Brachial Plexus* is formed by the union of the anterior branches of the lower cervical and first dorsal nerves, and extends from the lower part of the side of the neck to the axilla, being plexiform only in one part, and that not far from the neck. Around the plexus and the axillary vessels may be found traces of lymphatic glands imbedded in the areolar tissue.

Beneath the axillary vessels and nerves, with its deep surface resting upon the ribs and intercostal spaces, is the Serratus magnus muscle noted above; this muscle is covered in front by the Pectoralis major. The sternal digitations of this muscle in part overlie the small serially repeated external Intercostal muscles which extend from the tubercles of the ribs nearly to the outer end of the cartilages. The fibres of the Intercostals are attached to the adjacent margins of each pair of ribs, and are directed nearly parallel with the sternum. The action of the external intercostals is to elevate the ribs; they are, therefore, muscles of *in*spiration: in this action they are aided by part of some deeper muscles just within the ribs, termed the internal intercostals, *viz.*, that part apparent between the costal cartilages (from their outer end to the sternum), and whose fibres have a general oblique direction downwards (towards the sternum) and forwards (towards the head), therefore, to some degree crossing those of the external intercostals. The lateral portions of the internal intercostals, underlying the external intercostals, act as depressors of the ribs, and therefore aid in *ex*piratory efforts.

Removal of Sternum.—The student should now carefully clean the ribs and sternum from the junction of the clavicle with the manubrium*, down to the ensiform cartilage, until he can distinctly verify each rib. The sternal half of the diaphragm should then be separated from its attachment to the ribs with the scissors, and allowed to fall back; the student taking special care not to detach anything from its thoracic aspect, lest in doing so he separate the Phrenic nerves which reach the diaphragm right and left of its centre. The Ribs should then be divided on either side, following the line of junction between the true ribs and the costal cartilages; and the clavicle dislocated from the manubrium. Great care will be necessary to avoid puncturing the vessels anteriorly. The internal surface of the thoracic wall should be freed from the lining membrane (pleura) with the handle of the scalpel as it gradually admits of separation from the enclosed organs; this done, the sternal wall of the thoracic cavity should be removed.

The bag of the Pleura being now opened, the cavity with its contents will be ready for examination. Anteriorly is the Sternal attachment of the sterno-mastoid muscle, and the Thymus gland. Next is the Heart in its pericardium, and on either side the Lungs. The size of the thoracic cavity varies during life, both transversely and in depth, concomitantly with the situation of the ribs and diaphragm in breathing. The *Pleura* are two serous membranes or closed sacs, which are reflected around the Lungs in the cavity of the thorax. These pleural sacs approximate, but do not blend, along the middle line; and this median portion thus constructed of two membranes is termed the *mediastinum*†. The part of the mediastinum in front of the Heart extends from the pericardium

* *Manubrium*, a handle: the Sternum being looked on as a short broad dirk, the ensiform cartilage being the point.

† Mediastinum, *medius* the middle; *sto*, I stand.

to the inner surface of the sternum: and if the student will hold up gently with the forceps this upper portion, he will see the sort of inverted λ thus formed; the stem being mediastinum anterior; the branches, the internal side of the pleural sac on each side; the space between the branches being occupied by the pericardium, or membrane surrounding the heart. On gently pulling down the diaphragm, the thin white cords of the Phrenic nerves will be apparent; coming down nearly in a straight line ventrad of the roots of the Lungs and by the side of the pericardium (*i.e.*, between it and the mediastinal portion of the pleura), to the Diaphragm.

Exposure of Vessels, &c., in the Neck.—When the Student made the incision in the median line through the skin from the symphysis of the lower jaw, and reflected the skin on either side; he by this means exposed the sub-maxillary gland, as a large pinkish mass. This should be divided in the middle line, as also the sterno-mastoid, sterno-thyroid, and other muscles more or less closely connected with it in the neck, and reflected to each side, by which means the trachea will be exposed, and the vessels and nerves on either side of the neck.

And here the Student will observe—*first,* that it is the external, and not the internal jugular that is the main trunk by which the blood from the interior of the skull returns to the heart in these Rodents, and which by its confluence with the vein from the anterior limb constitutes the vena cava descendens: the internal jugular being here represented only by a small vein passing dorsad of the clavicle, and forming the third confluent tributary in the same relative position as in Man; and—*secondly,* that in forming this union the external jugular *crosses the clavicle on the outside,* and then together with the subclavian penetrates into the thoracic cavity in the interval between the clavicle and the first rib, the two veins uniting as they enter the cavity. Thus in two

points does the arrangement of these vessels differ from that in Man, where the external jugular runs parallel with the posterior border of the sterno-mastoid muscle as far as its attachment to the clavicle, and then perforates the deep fascia dorsad of the clavicle to join the sub-clavian vein; and—the internal jugular is the chief vein from the head.

Dissection of Phrenic Nerves.—The Student should now remove the mass of Thymus gland that hides the continuation of the jugular and subclavian veins in their course towards the Heart; and be careful not to cut away the pericardium with it, nor injure the vessels covered by it.

To find the left Phrenic nerve, he will first note the curve made by the descending cava round the first rib, and the crescent it forms immediately afterwards, of which the second left rib might form the centre. If then he carefully dissects on the concave side of the crescent, he will find close adherent to the vessel, at a point just opposite the second rib, a thin white cord, which is the left Phrenic nerve. This he should trace back nearly in a straight line ventrad of the root of the single-lobed left lung, by the side of the pericardium, between it and the mediastinal portion of the pleura; and by the left side of the fourth lobe of the right lung, to the diaphragm. The right Phrenic nerve may be traced in the same way, from the internal aspect of the concavity of the crescent of the right descending cava, along the outer side of its posterior termination, across the roots of the right lung, and along the course of the ascending or inferior cava to the diaphragm. These diaphragmatic or Phrenic nerves take origin from the posterior cervical nerves, and are therefore *spinal*, not cranial nerves.

The existence of a *left vena cava descendens* is again a point to be noted, as different from the arrangement of vessels usually found in Man, where the left jugular and subclavian

veins cross over by an 'innominate' vein to form, with the corresponding vessels on the right side, one vena cava superior.

EXAMINATION OF LUNGS AND HEART.—The Lungs will be seen to be freely suspended in the Pleural cavity, and to bear no marks of the ribs, &c., on their exterior. They are made up of five lobes, of which some are apportioned to the right and some to the left section of the organ, according as they are supplied from the right or left primary branch of the pulmonary artery. In this specimen four lobes enter into the composition of the right Lung; the fourth lobe being in the middle line in relation with the apex of the heart above, and the left Phrenic nerve on its left; this lobe, in excess of the three-lobed constituents of the right Lung in Man, is termed the *post-caval* lobe, as being notched on its dorsal surface for the passage of the inferior cava, after it has pierced the diaphragm *en route* to the Heart.

Between the post-caval lobe and the left Lung, dorsad of the left Phrenic nerve, the student will readily perceive the Œsophagus with the Pneumogastric nerve lying on it, which, after piercing the diaphragm, continues forward dorsad of the root of the left Lung. Further he will note the anterior margin of the left Lung, and of the anterior lobe of the right Lung to be indented by the descending cava of each side; that of the left side passing ventrad of the root of the left Lung, and winding round the left contour of the Heart to reach the back of the right ventricle. The two descending cavæ thus enclose in their grasp the roots of all the vessels leaving the heart.

The *root of the Lung* will be seen to consist, on its ventral aspect, of the vessels proceeding between the Lungs and the Heart, *viz.*, the pulmonary arteries and veins; dorsad of these, and hidden by them, are the air tubes or Bronchi, which by their union, as will be shown presently, form the Trachea: dorsad of the Bronchi, as may be seen by lifting up the left

Lung, the Œsophagus passes, as above noted: dorsad of the Œsophagus, close to the back and slightly to the left of the median line, being partially hidden by the left lobe of the right Lung, will be found the Aorta, of which the abdominal portion (up to the Diaphragm) has been previously traced: and lastly, in the anterior portion of the Thorax, coming away from between the ventral aspect of the spinal column, and the Aorta, will be seen the Vena Azygos of the left side, which, after passing round the root of the left Lung, joins the left vena cava descendens.

The *stratification of the three chief systems of the body* may be here noted, and should be well borne in mind, for it is characteristic of all Vertebrata to have the *Vertebral column with its contained nervous system dorsal, the Heart ventral,* and *the Digestive system intermediate to the other two.*

Dissection of Vessels and Nerves in the middle line between the cut ends of the First and Second Ribs on either side.—The Heart lies opposite the middle of the Sternum, its longitudinal axis inclined obliquely from above downwards, slightly backwards and to the left: being, as it were, dependent from the vertebral column; consequently, the apex alone comes near the Sternum.

By cleaning carefully the vessels at the anterior part of the base of the Heart, their relative positions will be found to be as follows: to the right, the right vena cava descendens; and next, the commencement of the arch of the Aorta (not colored by the injection), from which a branch proceeds straight forwards between the vena cava and the Trachea, which is the Innominate Artery. This Artery should be traced forwards with great care to about opposite the cut end of the first rib, where it will be found to bifurcate, one branch continuing onwards as before, which is the right common carotid; the other branch bending under the point of junction of the

jugular and subclavian veins, and forming the right subclavian artery. *Now* the Student will see the reason of his care, for crossing the subclavian artery at its point of origin, and running forwards parallel with the Trachea, at first external to the carotid, and then crossing it about a quarter of an inch further forwards than the bifurcation, is the right Pneumo-gastric Nerve. This Nerve may now be traced back between the Innominate Artery and the right cava, and forwards in company with the carotid artery. We have thus demonstrated on the right side, the Phrenic nerve on the right of the right cava, and the Pneumo-gastric on the left of the right cava, at the point just opposite the cut end of the second rib.

Now let the Student cut through the vena cava as it courses round the *first* rib, and immediately dorsad of this vessel he will find the *Phrenic* nerve continuing its straight course, and passing ventrad of the subclavian artery, about one eighth of an inch from the spot where the Pneumo-gastric crosses it. This nerve may be now followed up in the neck, and by this means its whole course is exposed, which, briefly summarized, is as follows:—commencing in the cervical region near the Thyroid cartilage, it courses down the neck, crosses the subclavian artery dorsad of the vena cava superior, on the side of which it continues to the Heart; it then crosses ventrad of the roots of the right Lung, and follows the course of the inferior cava to the Diaphragm.

If now the left vena cava descendens be slightly raised at the corresponding point, the Student may, by careful dissection, make out the difference between the arrangement of arterial branches on this side, as compared with the other. First he will come upon, near the middle line, the left common carotid artery, arising direct from the Aortic arch, across which, closely adhering to the inner side of the left cava, he will find the left Pneumo-gastric nerve to run; and secondly, a little deeper, he will come upon the left subclavian artery, also

arising directly from the arch of the Aorta, but external to the carotid. The arch of the Aorta will be seen to turn over towards the back and left side, then to cross over a highly-injected vessel, which is the pulmonary artery arising from the right ventricle, and then to disappear dorsad of the left cava, and proceed towards the back-bone. If the cleft between the right auricle and ventricle be looked into, the root of the Aorta will be seen to take origin dorsad of, and rather behind the root of the pulmonary artery.

Removal of Left Lung.—The Left Lung should be now removed by section through its root, and the left descending cava cut across, leaving the Phrenic nerve in situ, and the Pulmonary artery and Aorta untouched. By this means may be seen the intermediate course of the Pneumo-gastric nerve, which will be best traced from the point we left it last, *viz.*, where crossing the subclavian artery; from this point it is readily followed downwards ventrad of the Aorta, almost adhering to the dorsal aspect of the Pulmonary artery, and reaching the Œsophagus at the point where the Trachea comes first into apposition with the Œsophagus, just dorsad of the root of the left Lung.

By this section, also, may be traced the course of the Aorta, after giving off the left subclavian artery; at first in close apposition with the left of the Trachea, then of the Œsophagus, and lastly, taking up a position almost dorsad of the Œsophagus, but slightly to the left, in which position it continues its course down the back, in the inter-pleural space ventrad of the spine, until near the Diaphragm, at which point, as above noted, it is directly dorsad of the Œsophagus.

It will thus be seen that the Aortic trunk is single, which is a characteristic of all warm-blooded animals; and secondly, that this *single trunk arches over towards the left*, encompassing the root of the left Lung, a matter to be

noted in contradistinction to the direction of the Aortic arch in the Bird.

By turning up the apex of the Heart, the course of the left vena cava may be traced round the base of the ventricles behind, dorsad of the pulmonary vessels (which may be seen on either side towards the Lungs), to be joined some distance to the left of the right auricle by the ascending cava, forming a large sinus at the back of the Heart.

Examination of Trachea.—The Student should now cut across the right vena cava descendens near the auricle, and the Aorta near the Heart, and pressing the Heart backwards dissect away the connective tissue and remains of pericardium at its base. By this means he will be enabled to see the bifurcation of the pulmonary artery, and just internal to this, but following the same directions, the subdivision of the Trachea into the two Bronchi: the swelling contained within the angle of the pulmonary artery being the point of junction of all the pulmonary veins on their entrance into the left auricle. By cutting through these Pulmonary vessels as they come into view, and lastly by cutting through the ascending cava near its entrance into the right auricle, the Heart may be removed.

The Heart differs little from that of the Sheep, and it will therefore be unnecessary to enter here into a particular investigation. The enormous thickness of the walls of the left ventricle, and the extreme tenuity of the walls of the right ventricle should, however, be noted, as also the great extent of the sinus at the back.

Removal of Right Lung.—The Trachea may be now cut through just posterior to the arch of the Aorta; but care must be taken not to cut through, at the same time, the Œsophagus, which is closely adherent to the dorsal aspect of the Trachea at this point: and the right Lung removed. Here the Student should remark that the

Trachea consists of a series of pieces of cartilage, segments of rings, which are connected together by fibrous tissue, each piece of cartilage forming an incomplete ring. By placing a piece under a low power of the microscope, he will further note that between the ends of the cartilages is a continuous transverse layer of unstriated muscle, which is attached to the truncated ends and the inner surface of the cartilages, underlying a few superficial longitudinal fibres. The mucous membrane lining the tube is furnished (when fresh) with a columnar, ciliated epithelium. Again, it will be noted that the right Bronchus is subdivided near the Lung, into as many primary branches as there are lobes, and that in point of position each Bronchus is situated dorsad of the pulmonary arteries and veins.

If now the Student will make a flat section of one lobe of the Lung, cutting it in the direction of its largest superficies; and a second, straight through and across the lobe, he will be enabled to see the larger branches of the bronchi, and their mode of branching; also the blood-vessels, and the general cellular structure throughout. If specially injected and hardened (when fresh), the structural changes in the air-tubes should be examined under a microscope; the pieces of cartilage seen in the Trachea becoming broken up in the smaller bronchial tubes, and scattered over the wall as irregular fragments, and lastly disappearing: the fibrous and elastic tissues of the bronchial tubes being alone continued to the air cells.

DISSECTION OF SYMPATHETIC CORD, &c., IN THE THORAX. —Ventrad of the spinal column, lying in the interpleural space, are the Aorta, Azygos Veins, Œsophagus, and Splanchnic Nerves, all of which should be traced out.

If the Student will examine the wall of the Thorax, about a quarter of an inch to the right of the middle line, he will trace a slight seam taking a longitudinal direction. This

should be carefully followed with the point of the scalpel; and at a little depth below the surface he will come upon a white cord. This is the cord of the Sympathetic Nerve, which lies just ventrad of the bodies of the Vertebræ: its fibres may be traced forwards dorsad of the Azygos Vein, to about the level of the second rib, and backwards to the diaphragm. In such a small subject, the Sympathetic is not easily traced, except by a practised hand, through the anterior aperture of the Thoracic cavity; and should the Student attempt to trace the right Sympathetic cord, he must follow it up dorsad of the subclavian artery, about one eighth of an inch from its origin at the Aorta; and then along the side of the carotid artery. Under a lens the ganglia on this cord should be noted: especially opposite to the cut ends of the first and second ribs. There may also be noted branching from it, about an inch anterior to its perforation of the diaphragm, a smaller nerve, the great Splanchnic, which perforates a crus of the Diaphragm. On the left side of the body, the left Azygos Vein, the entrance of which into the vena cava descendens was noted above, should be traced back alongside of, but slightly dorsad of, the Aorta; on its dorsal aspect will be found the corresponding cord of Sympathetic Nerve.

The Aorta and Œsophagus should both be cleaned, and the Pneumo-gastric nerves left in situ, one on each side of the Œsophagus.

In the neck, the Phrenic nerve being very fine is not easily traced to its origin; but the Sympathetic and Pneumo-gastric should be traced up to the Head, closely adhering to the Carotid artery. The common Carotids should be followed up on either side to the point of their bifurcation into the internal and external Carotids, which will be found to take place on the level of the anterior termination of the Trachea, *viz.*, opposite the Larynx.

DISSECTION OF SALIVARY GLANDS.—The Student should

now with the scissors make the two following cuts: one from near the angle of the mouth to the anterior corner of the eye, and another from the front of the ear, in a direction above the level of the eye; and join these two cuts along the lower margin of the eye. This piece of skin should be dissected away, and also the underlying superficial muscles and fascia.

There will then be apparent the outer margin of the almost conjoined Hybernating and Submaxillary Glands, which were reflected in a previous dissection; and between them and the Ear the Parotid Gland. From the lower margin of the Parotid Gland, a duct will be seen passing to the angle of the mouth: this is the duct of the Parotid —Steno's duct. The muscle over which it passes on a level with the teeth of the lower jaw, is the Masseter muscle. Between the upper margin of the Parotid Gland and the Eye, a second perfectly distinct gland of a darker hue (in the fresh state) than the Parotid may be made out, from which a rather broad duct proceeds to enter the orbit; this gland is the facial, extra-orbitally placed portion of the Lachrymal Gland. The orbital portion of this gland may be brought to view, together with the Harderian Gland, by gently pressing the eyeball upwards and forwards.

Dissection of Anterior Factors of Descending Cava. —The Student should now clean and separate the three glands just seen from one another, turning the Submaxillary downwards, the Lachrymal up over the Ear, and leaving the Parotid in situ. By dissecting in the substance of the Parotid Gland, the Student will find the vessels from the face uniting to form the commencement of the temporal vein, which reaches from the Zygoma on which it rests to the angle of the jaw, and is succeeded by the external jugular vein. He should then trace this back along its course, which is marked by a line from the angle of the lower jaw to the clavicle, crossing the sterno-mastoid muscle; and will note

that it is joined, a little distance anterior to the clavicle, by the anterior jugular vein, which arises from the convergence of some superficial branches in the submaxillary region.

The further dissection of the Head will be better traced in a larger subject, *e.g.*, the Head of a Sheep, to which we propose to call the attention of the Student for his next dissection.

IV. THE CEREBRAL NERVES, &c.

AS DISSECTED IN THE

SHEEP'S HEAD.

GENERAL EXAMINATION. The Sheep's Head as usually supplied from the market is devoid of skin, and without its external ears; the junction of the Ear with the Head being indicated by the cartilaginous portion attached to the external auditory meatus.

The occipital condyles stand out clearly, denuded of their connections with the first cervical vertebra or Atlas; between them is the cut end of the spinal cord, surrounded by its loose sheath of Dura Mater; loose, that is, around the cord which is much smaller than the sheath; but attached to the ventral segment of the circumference of the Foramen Magnum. The cord itself presents in its section the shape of a flattened cylinder, and will be found to be closely invested with a dense white coating, or Neurilemma,* formed by the membrane called Pia Mater; between this Neurilemma and the sheath of Dura Mater is the cavity enclosed by the delicate, serous, Arachnoid membrane. The section of the

* Neurilemma. *νευρον*, a nerve; *λεμμα*, a peel or covering.

cord also displays—the dorsal and ventral fissure by which it is divided into two equal and symmetrical portions;—the arrangement of grey matter in two crescentic masses, placed one in each lateral half of the cord, with their convexities towards each other, each crescent having a dorsal and a ventral horn, of which the ventral is much the larger and fuller; and lastly—in the centre, the central canal of the spinal cord, which opens anteriorly into the Calamus Scriptorius of the fourth ventricle. The cord in its sheath rests upon the basi-occipital, and is roofed over by the supra-occipital bone; the main bulk of the condyles being made up of the ex-occipitals, though also containing a portion of basi-occipital.

In the middle line, on the crest of the supra-occipital bone, will be found some yellow elastic substance, which is the anterior extremity of the ligamentum nuchæ. This ligament extends from about the second dorsal spine posteriorly, and supports the weight of the head and neck. Likewise on the supra-occipital crest, but external to the ligamentum nuchæ, on either side will be seen a muscle cut short: this is the origin of the Splenius muscle, which is situated along the side of the neck, and is inserted into the transverse processes of the posterior cervical vertebræ, and the spinous processes of the anterior dorsal vertebræ;—taken together, their action is to elevate the Head; singly, they flex the Head to one side.

About half an inch ventrad of the external margin of each occipital condyle, the firm point of a bone will be felt; this bone will be the par-occipital process, a development of a process homologous with the jugular process in Man.

From the root of the par-occipital (close to the condyle) an imaginary line drawn forwards to the ventral margin of the orbit will pass through the Ear cartilage, and along the Zygomatic arch.

Just anterior to the Ear is the situation of the condyle of

the jaw, ventrad of the Zygomatic process; and in a relative position dorsad of the Zygoma is the situation of the coronoid process of the jaw.

Immediately above the cartilage of the Ear will be seen a knob of muscle: this is the Temporalis vel Temporo-maxillaris; it fills up the Temporal fossa of the Skull.

The limit of the Brain cavity anteriorly may be marked by a line drawn between the orbits, just in front of the ridge of the Frontal bones; hence to expose the Brain with a view to getting it out entire, the saw should be passed through the skull bones in a horizontal line from the occipital condyle to the middle of the Frontal ridge.

Attached to the Head will be generally found the anterior portion of the Trachea, recognised by its ringed structure; and dorsad of the Trachea, in close connection with it, the anterior end of the Œsophagus.

If a line be drawn from the outer margin of the occipital condyle, passing just internal to the point of the par-occipital process, to the outer margin of the Œsophagus; such line will pass the generally patent orifice of the cut end of the 'common carotid,' about an inch ventrad of the par-occipital process.

Dissection of Parotid Gland, &c.—Placing the Head with the side of the Face towards him, the Student will first consider the position of the superficial structures he is about to dissect, as follows:—The Parotid Gland lies almost in a straight line along the posterior margin of the ramus of the jaw, coming round on to the face but slightly at the angle of the jaw, but extending further forwards close by the Ear. From just within the anterior margin of this gland, there issue across the face several nerves and one duct, in the following order: first, there are two fine nerves in a line from the ear to the angle of the mouth; half an inch below these, in a line from the occipital

condyle to the angle of the mouth, is a larger nerve branch; an inch and a quarter below this, in a line from the par-occipital process to a point about two inches along the 'body' of the jaw, is a duct; lastly, a quarter of an inch below this duct, running in a parallel direction, is another nerve.

The *fat should be now removed* from the surface of the Parotid Gland, and it will be best to begin between the Ear and the par-occipital process, and then work forwards, being specially careful (when the anterior edge of the gland is reached) to *work towards the mouth, not across,* in order to avoid dividing the nerves and duct, which mainly lie in the direction of the mouth.

The Parotid Gland will be found to be limited above by the Zygomatic arch, to present a lobulated appearance, and to be of a reddish brown colour.

The Student will *next trace out the nerves,* &c., in the following order:

First, the large nerve twig (the second noted above), an inch and a half from the top of the gland, should be cleaned forwards as far as is possible*, and then should be traced back in the substance of the Parotid, where it curves upwards as it gets deeper, in a direction between the Ear and the *condyle* of the jaw; and here the Student must be careful not to injure a second nerve he will meet with deep down, coming in from the direction of the *angle* of the jaw. When this last nerve is reached, it should be traced forwards through the substance of the gland, in a direction towards the angle of the jaw; it will be found to be the lowest of the four mentioned in the first instance; and should be traced forwards across the face, following close along the edge of the ramus. These two nerves thus traced out are the two terminal

* The anterior branches of it are frequently removed with the skin.

branches of the Portio dura of the seventh nerve, the motor nerve of the face; consequently, generally known as the *Facial Nerve.* The larger, and superior, of these two branches, emerging upwards and forwards through the Parotid Gland, and crossing the ramus of the jaw just below the neck of the condyle, is the *Temporo-facial branch*†. The other division, emerging obliquely downwards and forwards through the Parotid Gland, and dividing opposite the angle of the jaw into branches which are distributed on the lower part of the face and upper part of the neck, is the *Cervico-facial branch.*

The Student should next continue tracing the Facial Nerve further down in the substance of the Gland, and only just a quarter of an inch beyond the junction of the Cervico-temporal and Cervico-facial branches, and on the opposite side of the Cervico-temporal to that on which the Cervico-facial was found, he will come upon a nerve twig passing from the main stem just below the Ear, and curving round and upwards to reach the surface between the posterior margin of the orbit and the knob of muscle above the Ear which fills the Temporal fossa, above noted as the Temporalis or Temporo-maxillaris muscle : this is the *Auricular branch* of the Facial Nerve.

By continuing the dissection of the main nerve stem a bare eighth of an inch further into the Gland, the Facial Nerve will be traced down to its exit from the Skull, through the Stylo-mastoid foramen.

Secondly, he should trace the fine nerves near the top of the gland, in front of the Ear; these will be found to run forwards towards the angle of the mouth, and backwards, united, within the Parotid Gland, or rather between it and the internal layer of muscle, and not penetrating the substance of

† This nerve will be seen to be connected with the auriculo-temporal nerve, to be described below, as it crosses the ramus.

the gland; they should be traced deep down in front of the external auditory meatus, internal to the auricular branch of the Facial, and there left for the present. The Nerve of which some of the branches have been thus traced back, is the *Auriculo-Temporal* Nerve, a branch of the larger subdivision* of the Inferior Maxillary division of the Fifth or Trigeminal nerve. At the point at which we leave it, it has just turned up between the external ear and the condyle of the jaw, under cover of the Parotid; and we have seen it escape from beneath this structure and divide into several branches, some of which are *branches of communication with the facial nerve,* which they meet on the superior border of the Masseter muscle.

Lastly, the duct that intervenes between the two branches of the Facial Nerve should be traced in a curved horizontal direction (like the middle of the letter ∞), across the Masseter muscle; at first inclined to follow the direction of the Cervico-facial nerve; then, about an inch from the border of the Gland, curving upwards to the angle of the Mouth, which it passes by; and finally opening on the inner surface of the cheek by a small orifice opposite the second molar tooth of the upper jaw. In dissecting this out, it will be of great assistance to pass a bristle along it, or a fine probe, to give the direction. Very frequently the middle part of the duct is removed with the skin, but even then both ends should be traced; the anterior inch, which is much dilated as it perforates the buccinator muscle, and passes in company with the facial vein internal to the facial nerve and artery, being readily found in the detached gland connected with the Parotid, *viz.,* the *Glandula Socia Parotidis,* situated at the angle of the mouth, and whose duct opens into that of the Parotid. The

* This, the larger branch of the Inferior Maxillary, receives only a few filaments from the motor root; and hence is more of a sensory than of a motor nerve.

course of the Parotid duct is frequently marked by pigment. By tracing it a short distance within the substance of the gland, the component radicles of the main duct will be apparent coming in alternately from either side.

The *Nerves and duct should be next cut across* about the middle of their course, *and reflected* together with the subcutaneous fat, in order to expose the chief muscle of the face, which has been incidentally mentioned above, *viz.*, the *Masseter Muscle.* This muscle consists of several layers, intersected by tendinous bands, enclosed in aponeurosis. A superficial portion is marked out, *arising* from a tuberosity on the superior maxilla by a thick tendon, its fibres passing obliquely downwards and backwards, to be *inserted* into the outer surface of the posterior border and angle of the inferior maxilla. A middle portion of the muscle lies rather deeper, and arising from the ridge of the malar bone and anterior half of the Zygomatic arch, its fibres also passing to the angle posterior external surface of the ramus. A third and deepest portion, rising from beneath the Zygomatic process, is inserted into the external surface of the ramus, just below the Sigmoid notch, between the condyle and the Coronoid process.

One other muscle may be noted in close relation with a nerve, *viz.*, the *Levator labii superioris* alæque nasi, which is situated on the side of the face, arising close to the point of origin of the most superficial part of the Masseter, and extending forwards to the upper lip. By reflecting this muscle from its upper side, and cleaning away the subjacent fat by *longitudinal scraping,* the anterior termination of the infraorbital nerves will be disclosed. It will be remembered that from the Gasserian ganglion, near the commencement of the Fifth Nerve, three large branches proceed: the Ophthalmic, Superior Maxillary, and Inferior Maxillary. Of these the two first are purely sensory; at the present point in the dis-

section we come upon the termination of the second branch, *viz.*, the Superior Maxillary, which, after leaving the cranium together with the Ophthalmic through the Sphenoidal fissure*, crosses the lower part of the Zygomatic fossa, enters the maxillary hiatus, passes through the infra-orbital canal, and emerges on the face at the infra-orbital foramen, where we now find it dividing into numerous facial branches, especially nasal and labial, and in close relation with the ultimate fibres of the temporo-facial nerve.

The anterior inch and a half of the body of the inferior maxilla should be carefully examined (especially about an inch behind the teeth), for the anterior appearance of the dental nerve through the mental foramen: that nerve, namely, which traverses the dental canal in the inferior maxilla; entering the canal by the dental foramen, an opening one inch below the sigmoid notch on the inner side of the maxilla. The Dental Nerve is the largest of the three branches of the Inferior Maxillary Division of the Fifth Nerve.

The Temporal muscle above the cartilage of the Ear should next be cleaned, and its *origin* from the parietal ridge, part of the occipital crest, and zygomatic process, noted; as also its *insertion* into the coronoid process of the inferior maxilla, which will be found about an inch and a half behind the orbit.

If the Student will place a loose ramus of a sheep's jaw on his dissection in its proper position, he will be better able to make out the situation of the condyle, coronoid process, neck of condyle, ramus, &c., and the points of attachment of the Temporal and Masseter muscles.

And here (as in all Herbivora) he may note that the muscles more directly worked in mastication, *e.g.*, the Masseter and the Pterygoids (to be seen hereafter), are propor-

* In Man, the Ophthalmic leaves by the Sphenoidal fissure, and the Superior Maxillary by the foramen ovale.

tionally more developed than the biting muscles, *e.g.*, the Temporales.

DISSECTION OF GLAND DUCT, NERVES, AND MUSCLES JUST INTERNAL TO THE ANGLE OF THE JAW.—The Student will now turn the Head partially over, so that it rests on the side of the nose; and placing a block under the angle of the jaw, will strain the Larynx and Œsophagus over it, hooking them down to the table by means of a chain and hooks. In this way the Submaxillary Gland will be apparent, placed close below and behind the Parotid, on the outer side of the Pharynx; also the Paroccipital process, with a sharply defined muscle* proceeding therefrom in the direction of the lower jaw, beyond the angle; and lastly, a fleshy muscle extending all along the inner side of the ramus and angle of the jaw. These, together with the Duct of the Submaxillary Gland, will form our next objects of dissection.

The *submaxillary duct* will be found on the continuation of a line drawn from the extreme anterior margin of the orbit to the angle of the jaw: hence in dissecting away the gland-lobules from the fat and mucous membrane, care must be taken to avoid cutting across the duct; the best way to proceed being, first to dissect the mucous membrane, &c., in one sheet away from the muscle lying within the jaw, and reflect it; and then to stretch the sheet of membrane thus reflected, by which means the vessels and ducts ramifying in it may be readily detected. Proceeding from the middle of the gland in the direction indicated will be seen a pinkish aggregation of lines and vessels; this requires special and careful investigation, for, at the final reunion of the ducts from the lobules, just where the duct of Wharton commences, will be easily seen *a nerve ganglion of grey matter,* as large as a medium-sized pin's head; about one-eighth of an inch from, and rather larger

* The Digastric muscle.

than the first, is another ganglion; and lastly, there is one on each nerve strand which crosses the primary bifurcation of the duct, tracing it backwards: the whole forming as it were a second and posterior factor of the submaxillary ganglion, which will be noted later on in connection with the Chorda Tympani, after removal of the jaw.

Having found the duct and nerve plexus, a stoutish bristle should be passed up the duct, and the fat and connective tissue dissected away from the surface of the gland and adjoining structures: and here again care must be taken between the border of the gland and the occipital condyle, lest a large nerve cord be cut away which runs from the direction of the condyle parallel with the posterior margin of the ramus and angle of the jaw.

The submaxillary duct will be seen to run forwards between two muscles: of these, that inserted into the inner posterior border, and angle of the inferior maxilla, is the *Internal Pterygoid* muscle, which takes its origin mainly, as its name would imply, from the inferior part of the crest of the Palatine and Pterygoid bones. When acting singly these muscles produce a lateral motion, together they raise the jaw and close the mouth.

The second and internal of the two muscles is the *Digastric**, a long thin muscle that runs alongside the inner edge of the ramus of the maxilla, attached to the inner edge of the horizontal part of the jaw, and to the Paroccipital process: it is so called from its consisting of two fleshy bellies united by an intermediate tendon. In two points its arrangement differs from that in Man; first, in that its tendon does not perforate the Stylohyoid muscle; and, secondly, in that it does not arise from the digastric groove on the inner side of the mastoid process of the temporal bone; which would be impos-

* δις, twice; γαστηρ, a belly.

sible, for the mastoid process of Anthropotomy is here represented by a small separate stunted bone intervening between the paroccipital process (external jugular of occipital in Man), and the post-tympanic process of the squamosal.

And here it may be noted as a general statement that all the muscles attached in Man to the Mastoid process, in this animal are attached to the paroccipital process instead.

The small muscle running across, and external to the posterior belly of the Digastric, will be traced back to arise from a moveable bony head just internal to the point of the paroccipital process; this moveable ossicle is the end of the styloid bone (a process of the tympanic in man): forward it will be traced internal to the Submaxillary gland and duct; and by reflecting forwards the gland substance posterior to the duct (carefully leaving the duct and nerve plexus in situ) this muscle may be seen to be inserted into a moveable ossicle, in the middle line between the rami, and a little anterior to the angle of the jaws, the ossicle being a portion of the Hyoid bone. This muscle is therefore known as the *Stylo-Hyoid;* and its action is to draw back and elevate the os hyoides.

Internal to the Stylo-Hyoid Muscle is a large nerve trunk winding from within the Paroccipital process, in a course almost parallel with the posterior margin of the jaw. This is the *Hypoglossal Nerve,* the motor nerve of the tongue. This will be traced back later on, when examining the back, or base of the skull.

Removal of Lower Jaw.—The Student will now clean away and reflect upwards from the surface of the Masseter muscle the Parotid gland, and nerves ramifying therein; and then take a saw and make the three following cuts, only partially severing the bone, and completing the fracture by working a chisel in the groove, so as to avoid injuring the structures immediately internal to the bone by cutting too deep with the saw, *viz.* :—1, from the angle of the mouth

across the ramus of the jaw, about an inch and a quarter from its lower margin.—2, in a sloping direction across the anterior part of the body of one jaw, about two inches from the teeth and symphysis respectively, posterior to the mental foramen;—and 3, a similar cut in the same direction and situation on the other jaw. Then, taking a scalpel, he should scrape away the muscular attachments, &c., along the margin of that jaw the ramus of which has been fractured, and continue the same operation on the inner surface of the jaw, removing as far as possible the periosteum at the same time, so as to avoid cutting any structures internal to it; pressing the bone away with the thumb of the left hand, and following close to the bone with the scalpel in the right hand. The saw will have cut through the Inferior dental nerve (mentioned above), just as it has penetrated the substance of the Inferior Maxilla to pass forwards in the dental canal beneath the teeth; and again, just before its appearance on the outside of the jaw at the mental foramen. This nerve being the second branch of the Inferior Maxillary division of the Fifth Nerve we have seen; the first being the Auriculo Temporal branch distributed on the face.

Examination of Body of Jaw.—The Student will do well now to follow the Dental Nerve in the canal contained within the maxilla. This may be accomplished by taking a chisel and mallet, and making a fracture along the inner side of the anterior two-thirds of the jaw, and then placing the chisel just under the upper edge of the fracture, chipping the bone away towards the teeth and gums along their entire course. By removing this inner plate of bone the implantation of the molars will be well seen; and generally, at the age a sheep is killed for food, a sac will be disclosed containing a molar tooth in process of formation, posterior to the last molar visible through the gum; as also three more sacs with teeth, beneath the three anterior teeth that have

reached the surface. Lastly, underlying the whole series of teeth will be seen the enormous Inferior Dental Nerve, from the dental to near the mental foramen; and along with it the Inferior Dental branch of the internal maxillary artery (one of the terminal branches of the External Carotid) which supplies the teeth.

Now the fact of the three anterior teeth in the body of the jaw having other teeth beneath them, shows them to be deciduous or *milk teeth*; and the two next teeth having no such reserve supply, are thereby shown to be two of the *true Molar* series. But, supposing the internal economy of the jaw were not laid bare, we could still predicate of the three anterior teeth that they were milk teeth; on this ground,—most of the deciduous molars of the Ruminantia resemble, in the form of their crowns, the true molars, *i.e.*, the crowns present throughout a similar complexity; and again, the last milk molar has three lobes like the last true molar (which in this case has not yet cut the gum); whereas the premolar permanent series that replace the milk deciduous molars have more simple, or less complex crowns than their predecessors, and are, therefore, less complex than the posterior teeth of the series:

DETERMINATION OF AGE—this is of value in ascertaining the age of the beast, for if on examining the jaw the third tooth presents a greater number of lobes than those in advance of it, and all the series look pretty much alike, it is quite certain that none of the premolar series are yet in place. In other words: since

In the *Sheep*—

Both anterior and second Premolar appear from the twenty-fourth to the thirtieth month, and the posterior Premolar appears from the twenty-seventh to the thirtieth month, it is quite clear that the beast has not attained its second year.

Being satisfied that the milk molars are still in place, the next point to note is how many true molars have cut the gum, for

In the *Sheep*—

The anterior molar cuts the gum from the third (early) to the ninth (late) month; the second molar cuts the gum from the ninth (early) to the twelfth (late) month; and the posterior (tri-lobed) cuts the gum from the eighteenth (early) to the twenty-fourth (late) month.

Hence if, as here, two molars only can be felt, each bilobed, posterior to the trilobed milk molar, you know the sheep to be over nine months and under eighteen months old. But there remains a simpler test of age than this, by referring to the teeth that fringe the anterior margin of the jaw.

These teeth will be seen to be eight in number, of which the three on each side nearest the middle line are called Incisors; and the outer one on each side is called a Canine tooth. All this series, in course of development, goes through a process of replacement; and in this process the teeth assume a different shape; the first set being small and narrow, with an almost circular blunt grinding surface; the second set broad and large, with a trenchant edge, and brown markings, like two leaves, on the inner surface. The central pair alone represents the permanent series in the case before us.

Now in the *Sheep*—

The permanent central incisors appear from the twelfth (early) to the twentieth (late) month; the permanent internal lateral appear from the eighteenth (early) to the twenty-eighth (late) month; the permanent external lateral appear from the twenty-seventh (early) to the thirty-sixth (late) month. The corner pair, or Canines, appear from the thirty-sixth (early) to the forty-second (late) month.

In this case the central pair of permanent Incisors, commonly called the *Nippers*, being up, and no others, we

know the beast to be under eighteen months and *over twelve* months old; from the Molar series we concluded it to be under eighteen months and *over nine months* old. Hence we may certainly conclude the animal before us to have been from twelve to eighteen months old*.

EXAMINATION OF THE DEVELOPING TOOTH AND OTHERS.—By removing the capsule around the posterior tooth of the Molar series, the different structures of a tooth may be made out. The soft pulpy material at the base is the Dental pulp, a soft, highly vascular, and sensitive substance, accurately filling the central cavity of the tooth. The lower part of the solid portion of the tooth is composed of Dentine, which forms the principal mass or foundation of the body of the tooth, gives the general form, and immediately encloses the cavity. The upper part is formed of Enamel. It will be well now to remove this Tooth and place it in a solution consisting of two parts of Nitric Acid and one part of Chromic Acid in one hundred parts of water, with a view to making a longitudinal section through the tooth when it is soft enough to admit of cutting, to show the external coating of enamel, the inner coat of dentine, and the central pulp cavity in their relative positions.

We may note here, as in all Ruminants,—that the outer contour of the entire Molar series is slightly zigzag, the anterior and outer angle of one tooth projecting beyond the posterior and outer angle of the next in advance; also,—that in most of the deciduous series, but in the three posterior teeth only† of both upper and lower jaws in the permanent series (*i.e.*, the True Molars), may be seen the characteristic complexity of the Ruminant grinder; the grinding

* The Head under dissection having been purchased in September, it is probable that the lamb was born late, about March.

† The three first or premolars have, as before said, more simple crowns than those which they displace.

surface being marked in the centre by double crescent-shaped ridges of enamel, so disposed as to present along with the central mass of dentine, and external crust of cement, alternate layers of hardened tissue, having different degrees of density: the complexity in question being the result of peculiar plications of the formative capsule, some of which are longitudinal, or project inward from the sides of the capsule, and form peninsular folds of enamel upon the grinding surface of the tooth, whilst others depend vertically from the summit of the matrix into the body of the tooth, and form islands of enamel when the crown begins to be worn†; and, lastly,—that the last true Molar of the lower jaw presents the character found in all Ruminants, *viz.*, a third, posterior, lobe.

Dissection of Digastric and Mylo-Hyoid Muscles, and Mylo-Hyoid Nerve.—By the removal of the jaw as described above, the Student will be enabled to investigate from the side the relative positions of the muscles, nerves, ducts, and vessels: and will first note that the main bulk of the muscle that was removed along the inferior margin of the jaw was the anterior belly of the Digastric muscle; next that the more fleshy and massive muscle scraped away from the inner surface of the angle of the jaw was the insertion of the Pterygoid; and lastly, will observe the cut end of the Dental nerve where it was cut across in removing the jaw.

He should now dissect close along the internal aspect of the Pterygoid (being especially careful not to injure any of the delicate nervous structures near its anterior margin); and then turn it upwards, with a view to exposing the posterior inch of the duct of the Submaxillary Gland, and the tendon of the Digastric Muscle. Then dissect the long anterior belly of the Digastric away from the edge of the mouth, leaving in situ the muscle that lies internal to it, and whose

† Owen.

fibres are arranged at right angles to those of the Digastric, being very careful not to cut away the nerve that lies between these two muscles, whose apparent posterior extremity, *i.e.*, as far as at present traceable, is internal to the ramus of the jaw where it was cut across (and which may be therefore sometimes destroyed in the fracture).

The muscle immediately underlying the anterior belly of the Digastric is the Mylo-hyoid* ; it forms with its fellow of the opposite side a muscular floor for the cavity of the mouth ; and arises from the whole length of the internal superior margin of the body of the jaw (the mylo-hyoid ridge), from the symphysis to the last molar tooth. The posterior fibres pass obliquely backwards, and may be traced, internal to the Digastric, to be inserted into the body of the os-hyoides ; the middle and anterior fibres (as will be later shown) are inserted into a median fibrous raphe, where they join at an angle with the fibres of the opposite muscle. This *Mylo-hyoid* is distinctly double ; the anterior bundle having an extended longitudinal development, while the posterior division is short, and has its fibres directed transversely outwards.

The nerve exposed, running the whole length of the Mylo-hyoid muscle, is the Mylo-hyoid nerve, a branch derived from the Inferior Dental Nerve, just as that nerve is about to enter the dental foramen. It descended in a groove on the inner surface of the ramus of the jaw, in which it was retained by a process of fibrous membrane. It supplies the cutaneous surface of the Mylo-hyoid muscle, and the anterior belly of the Digastric.

DISSECTION OF CHORDA TYMPANI, GUSTATORY NERVE, WHARTONIAN DUCT, AND SUBMAXILLARY PLEXUS.—The

* μυλη, a mill, the jaw; and υ (the letter upsilon) εἶδος, shape, the thence-named Hyoid bone.

Mylo-hyoid muscle should be next dissected away* from its superior margin, and reflected downwards towards the middle line. In order to do this, the Mylo-hyoid nerve will have to be cut across by the fracture of the jaw, and turned over with the muscle. *Excessive care will be needed along the posterior margin of the muscle, in the line between the last upper molar and the duct of the Submaxillary Gland,* beneath which runs the Chorda tympani, and is located the anterior fraction of the Submaxillary ganglion. Just within the posterior-superior corner of the same muscle, and overlapped by the anterior margin of the (internal) Pterygoid above described, may be seen the broad white stem of the Gustatory Nerve. Close within the median raphe of the Mylo-hyoid above noted is lodged the submaxillary duct, in the middle of its course; and between the two branches of the gustatory nerve is situated the long sublingual gland, whose duct runs forwards a little above the Whartonian duct.

The *terminal course* of that branch of the Facial nerve called the *Chorda tympani,* is alone here brought into view. It has descended between the two Pterygoid (external and internal) muscles, and met the Gustatory nerve. It should be carefully dissected out, and will be seen again to quit the Gustatory nerve, and working backwards and downwards on the segment of a circle, to join the direction of the Submaxillary duct, in company with which we have noted it in a previous dissection. A reddish ganglionic mass may be made out in the fat about one-eighth of an inch in advance of the lower fifth of the Chorda; this is the anterior *Submaxillary ganglion.* From this ganglion filaments radiate; one larger filament going back to the Submaxillary gland and forward

* We must here again caution the Student to be extremely cautious to remove *only* the muscle, and leave the inter-muscular adipose tissue to investigate when the superjacent muscle is reflected.

in a direction parallel with the jaw, where it may be traced in the fat across the Gustatory nerve to end in the mucous membrane of the mouth. This ganglion also receives filaments from the Chorda tympani, and from the Gustatory nerve, which form a fine plexus in the triangle enclosed by the Chorda, Gustatory, and main ganglionic filament.

The *Whartonian Duct* takes very nearly a straight course along a line drawn from the Symphysis to the angle of the jaw; which line also marks the lower margin of the Styloglossus muscle. Three inches from the gland it is crossed by the inferior branch of the Gustatory nerve. By the aid of the bristle inserted into the duct, its course may be traced forwards in close connection with the Gustatory nerve, along what would be the inner side of the jaw, had it not been removed, between the Styloglossus muscle and Sublingual gland, to open into the mouth rather in front of the frænum linguæ, where it is protected by a thick papilla of mucous membrane, called a *barb* in cattle, the opening being guarded by a plate of cartilage.

The *Gustatory Nerve* or lingual branch of the inferior Maxillary division of the Fifth nerve will be noted to have descended under the anterior border of the internal Pterygoid muscle, and to lie internal to, and to the front of the inferior Dental Nerve* as it enters the jaw, at which point the Chorda tympani is in close relation with it. It then crosses obliquely to the side of the Tongue over the Superior Constrictor muscle of the Pharynx, and reaches the Styloglossus muscle, on the external surface of which it runs, and shortly after divides into two branches; the smaller branch continuing straight along the margin of the tongue to the anterior attachment of this organ, the larger branch descending to cross the Whartonian (submaxillary) duct about an inch and

* Cut short in the jaw.

three quarters in advance of the Submaxillary ganglion, and disappearing beneath the duct soon after.

The *Sublingual* is the smallest of the salivary glands, and is of a narrow oblong shape, situated between the two branches of the Gustatory nerve posteriorly, and between the upper branch and the Whartonian duct anteriorly; the lower branch of the Gustatory bending upwards internally to the gland about the middle of its length. The principal duct should be followed forwards, and at a point about three quarters of an inch from the papilla at its termination it will be seen to be crossed by the superior branch of the Gustatory nerve, and from the same point to become enclosed in the same sheath with the Whartonian duct, to the end of its course. A bristle passed along this duct will, however, shew that in many cases the two ducts remain distinct in the sheath, and open separately in the mouth; though in many cases the two ducts blend before opening into the mouth. This single canal from the Sublingual gland, entering the mouth anteriorly, is known as the *duct of Bartholini;* the several smaller ducts which unite to form the single canal being called the ducts of Rivini.

Of the three salivary glands now seen, the Submaxillary is said to be the first formed in the Mammalian fœtus; then the Sublingual, and lastly the Parotid.

INVESTIGATION OF THE CHAIN OF HYOID BONES.—The Student will do well now to raise the Pterygoid muscle and that part of the ramus of the jaw which remains in situ, and stretch it over towards the top of the skull by hooks, in order to expose the Stylo-hyal bone, with the muscles thereto attached.

Before noticing the muscles connected with the Os Hyoides more particularly, it may be well to direct the attention to its osseous framework. The *Hyoid bone* is made up* of a

* *Cyc. Anat. S.*, art. Ruminantia.

congeries of nine ossicles more or less consolidated, arranged in four pairs, the ninth piece being represented by the 'body' or Basi-hyal bone. The first pair, the *Stylo-hyals, immediately internal to the posterior border of the ramus of the jaw,* have an enormous longitudinal development, being also somewhat hammer-shaped and compressed laterally; their peculiar figure being due to the presence of two apophyses at the temporal extremity, by the superior of which the bony chain is connected by a short ligament with the cranium. The second pair, or *Epi-hyals,* are intercalated between the first and third pair of ossicles; the third pair (placed nearly vertical) make a right angle with the first pair (which lie horizontally forwards), and the second pair fill up the apex of this angle, which is directed forwards. The third pair, or *Cerato-hyals,* have a nearly vertical position when the head is raised. The body of the hyoid, or *Basi-hyal,* of a triangular form, is placed below the cerato-hyals, and anterior to the greater cornua or thyro-hyals. This fourth pair, the Thyro-hyals, articulate to the extremities of the lateral apophyses of the Basi-hyal, and lie nearly horizontally backwards, the whole series forming on each side a figure like the italic *z* sloping the wrong way.

In Man,

The *Stylo-hyals* are represented by the 'Styloid process of the temporal bone'; the *Epi-hyals* by the 'styloid ligament'; the *Cerato-hyals,* by the 'lesser cornua'; the *Basi-hyal* by the 'body'; and the *Thyro-hyal* by the 'greater cornua.' In the Ruminant, the so-called 'greater cornua' (of anthropotomy) are subordinate to the so-called 'lesser cornua' in the extent of their development.

REMOVAL OF PAROTID GLAND; AND DISSECTION OF STYLO-GLOSSUS, GENIO-HYO-GLOSSUS, AND GENIO-HYOID MUSCLES; AND HYPO-GLOSSAL NERVE.—The Student should now remove the posterior part of the Parotid Gland along

the track of the cervico-facial branch of the Seventh nerve, but leaving the nerve in situ. In so doing, a branch of the external jugular vein will be cut across, lying internal, and almost at right angles to this cervico-facial nerve: but the external carotid artery which lies in the same direction as the vein, only a quarter of an inch deeper, should if possible be kept in situ running between the posterior belly of the Digastric muscle and the Stylo-hyal bone. The head and proximal processes of this bone should be cleaned, and the bone exposed (freed from fat only) throughout its length. Within half an inch of the inferior extremity of the stylohyal bone will be seen the origin of the *Stylo-glossus* muscle, which extends forwards along the under surface of the tongue as far as the tip, and on whose external surface the Submaxillary plexus and the course of the Gustatory nerves have been exposed: the Whartonian duct has been shewn to run along its inferior margin.

The long tendon of the Stylo-hyoid muscle proceeding from the posterior apophysis at the superior extremity of the Stylo-hyal bone will be now readily seen, and the inferior attachment of the muscle to the base of the Thyroid cornua may be traced out.

Immediately above the origin of the tendon of the Stylo-hyoid muscle may be seen the insertion of the short triangular *Masto-styloid** muscle, which arises from the paroccipital process, and is inserted into the inferior apophysis of the hammer-shaped extremity of the Stylo-hyal bone.

The ultimate course of the Hypoglossal nerve may be next traced; and in order to this, the Mylo-hyoid muscle should be dissected quite down to the median raphe: care being taken not to injure the broad nerve tract that lies in-

* A special muscle found in the Carnivora Ruminantia and Pachydermata (of Cobbold).—*Cycl. Anat. and Phys.*, art. Ruminantia, p. 527.

ternal to it, and very little below the margin of the Stylo-glossus: the Whartonian duct should also be left in situ along the lower margin of the Stylo-glossus.

After removing the adipose tissue intervening between the fascia of the under-lying muscles, the following arrangement of the *principal muscular strata* will be disclosed.

From the direction of the last molar tooth, towards the Hyoid arch, just internal to the posterior part of the Stylo-glossus, will be seen the obliquely-placed fibres of the *Hyo-glossus, arising* from the side of the body of the Hyoid (or Basi-hyal), and inferior part of large cornua (or Thyro-hyals), and *inserted* into the side of the Tongue: being in relation therefore externally, with the Stylo-glossus superiorly, and the Mylo-hyoid and Digastric inferiorly; crossed by the Hypoglossal nerve and Wharton's canal; and in relation internally with the two horizontal layers of muscles, next to be treated of, *viz.*, superiorly the Genio-hyo-glossus, and inferiorly, next to the median raphe, the Genio-hyoid. Just anterior to the upper margin of the Hyo-glossus, and blending with it, will be noticed a thin band of muscle getting thicker anteriorly, situated on the under surface of the tongue between the Hyo-glossus and the muscle next to be described, (*viz.*, the Genio-hyo-glossus), and whose fibres blend with the fibres of the Stylo-glossus in front of the Hyo-glossus: this is the external aspect of the Lingualis inferior muscle, one of the intrinsic muscles of the tongue.

Next there will be seen an upper stratum of longitudinal fibres proceeding from within the anterior edge of the Hyo-glossus and Lingualis, along the inferior surface of the tongue to near the symphysis of the jaw. These are the fibres of the *Genio-hyo-glossus* muscle, which *arises* from the lateral aspect of the inferior maxilla, near its symphysis, and is *inserted* first into the substance of the tongue, and further back into the Cerato- and Epi-hyal bones (or lesser cornua) of the

Hyoid arch. It will be seen to be in relation superiorly, therefore, with the substance of the tongue: externally, with the Stylo-glossus in its posterior moiety; and the sublingual gland and duct, and Whartonian duct in its anterior moiety; and lastly, to be crossed in its middle third by the larger factor of the Hypo-glossal nerve.

Thirdly will be seen an inferior stratum of longitudinal fibres just internal to the raphe found between the Mylo-hyoids: these are fibres of the *Genio-hyoid* muscle, *arising* from the jaw near its symphysis and *inserted* into the Basi-hyal (or 'body' of the hyoid bone). The Genio-hyoid may be said to be between the Genio-hyo-glossus and the median raphe of the Mylo-hyoid.

The *Hypo-glossal* nerve will have been thus traced to take the following course. After passing internal to the Digastric, it proceeds beneath the Mylo-hyoid and inferior margin of the Stylo-glossus, lying between it and the Hyo-glossus; and is then continued forwards along the external surface of the Genio-hyo-glossus, which it finally penetrates, to reach the tip of the tongue.

At the same time a considerable part of the course of the *Lingual artery* will have been made out; arising from the external carotid artery as it crosses about the middle of the Stylo-hyal bone, it continues in the direction of that bone across the origin of the Stylo-glossus, dips down internal to the Hyo-glossus, between it and the Genio-hyo-glossus (where it runs parallel with the Hypo-glossal nerve), then ascending and working forwards on the under surface as far as the tip of the tongue under the name of the ranine* artery.

The *actions of the various muscles* hitherto described may be thus briefly stated.

First Group.—The Temporal, Masseter, and Internal Ptery-

* *Rana*, a frog; *also* a swelling under the tongue.

goid *raise the lower jaw* against the upper; and the two latter muscles, from the obliquity in the direction of their fibres, assist the External Pterygoid (to be seen later, after the removal of the Zygomatic arch) in *drawing the lower jaw forwards* upon the upper; the jaw being drawn back again by the deep fibres of the Masseter and the posterior fibres of the Temporal.

Second Group.—The Digastric *depresses the lower jaw.*

Third Group.—The Stylo-hyoid, Mylo-hyoid, and Genio-hyoid together *raise the Hyoid bone,* and with it the base of the tongue, during the act of deglutition.

Fourth Group.—The Genio-hyo-glossi, Hyo-glossi, and Linguales act separately. The *Genio-hyo-glossi,* by means of their posterior and inferior fibres draw upwards the Hyoid bone, bringing it and the base of the tongue forwards, so as to *protrude the apex from the mouth*:—their anterior fibres will restore it to its original position by retracting the organ within the mouth. The whole length of this pair of muscles acting along the middle line of the tongue will draw it downwards, so as to make it *concave from before backwards,* and form a channel along which fluids may pass to the Pharynx. The *Hyo-glossi* draw down the sides of the tongue, so as to render it *convex from side to side.* The *Linguales* by drawing downwards the centre apex of the tongue render it *convex from before backwards.**

Examination of Internal Pterygoid, and Superior Constrictor Muscles.—The Student will now take a fine saw, and cut through the zygomatic arch in two points; anteriorly, just behind the orbital ring; and posteriorly, about an inch from the same: he will then raise that part of the ramus of the jaw which still remains, and will first cut across a small muscle in the neighbourhood of the molar teeth,

* Gray.

which is the *Superior Constrictor Muscle;* and next will scrape away from the anterior margin of the ramus the attachment of another muscle, *viz.* the anterior and larger belly of the external pterygoid muscle. The object of the removal of the section of zygomatic arch is now apparent, *viz.* in order to admit of the extraction of the coronoid process of the jaw, which is next to be drawn outwards through the gap made, and turned over backwards; access being by this means gained for the examination of the second and shorter belly of the external pterygoid muscle which is attached to the under side of the internal angular prominence of the condyle of the jaw.

The *External Pterygoid* muscles are thus seen to occupy the major part of the zygomatic fossa: they *arise* by two heads placed close together, occupying a considerable area on the Sphenoid, Pterygoid, and posterior aspect of the Superior Maxillary bones. The fibres from both heads are marked with tendinous intersections, and have a general downward direction. When the muscles of both sides act together, the lower jaw is slightly drawn forward; but when the muscles of one side act alone, the result is the advancement of one condyle only, and hence the lateral motion of the jaw, throwing the teeth to the side opposite to that on which the muscles act. This action repeated alternately on both sides induces a lateral grinding movement of the lower teeth.

The inferior dental nerve should be removed from the dental foramen in the jaw, and left (as to its upper course) in situ, together with the mylo-hyoid branch which lies just posterior to it, and which will be, later on, traced back to the motor root of the inferior maxillary nerve: the buccal nerve should also be traced up, and cleaned. In laying bare these nerves towards the temporo-maxillary articulation, a large vessel will be noted crossing them at right angles; this is the internal maxillary or *deep Facial artery,* the larger of the two

main terminal branches of the external carotid. It may be traced back into the internal substance of the Parotid gland, by which its origin below the condyle of the jaw is concealed; and at the point at which it crosses the inferior dental nerve it may be seen to curve horizontally forwards between the jaw and the internal lateral ligament of the temporo-maxillary joint; thence it may be traced obliquely forwards and upwards on the outer surface of the smaller belly of the external Pterygoid muscle; and then inwards between the two bellies of this muscle, just internal to the buccal branch of the inferior maxillary nerve (which crosses it at right angles), to the spheno-maxillary fossa, where it divides into two main branches: the bifurcation taking place immediately internal to a hooked process which projects backwards from that upper part of the sphenoid bone known as the Ali-sphenoid.

In tracing the Internal Maxillary Artery backwards care must be taken not to cut across that branch of the external carotid which supplies the Parotid gland, and which leaves the upper side of the bend of the internal maxillary much in the same way as the carotids themselves leave the aortic arch. And secondly, care must be taken to avoid cutting through the auriculo-temporal branch of the inferior maxillary nerve which was first exposed as the superior nerve tract in the dissection of the Parotid gland.

REMOVAL OF CORONOID PROCESS, PART OF THE CONDYLE, AND REMAINS OF RAMUS OF LOWER JAW.—The Student should now take a fine saw, and cut part of the way through the internal angle of the condyle of the jaw, completing the fracture with the 'bone-nippers' so as to avoid injuring the subjacent structures; remove the bone; and also cut away the unattached portions of the anterior belly of the external Pterygoid, avoiding any injury to the buccal nerve which lies internal to it, as it courses from the posterior angle of the superior maxilla towards the inner aspect of the

temporo-maxillary joint. The point of intersection of the internal maxillary artery and the buccal nerve well defines the separation between the two bellies of the external Pterygoid muscle.

The Student should have before him at this stage of the dissection the following nerve branches between the Par-occipital process and the orbit, *viz.*,—on the posterior aspect of the Parotid gland, the Cervico-facial, Temporo-facial, and Auricular branches of the Facial or portio dura of the Seventh* nerve, converging to meet just behind the external meatus of the Ear:—on the internal aspect of the Parotid, the Auriculo-temporal branch of the Inferior Maxillary nerve passing inwards close to the remains of the condyle of the jaw:—on the external aspect of the Internal Pterygoid muscle, in order from behind forwards, first the small Mylo-hyoid nerve closely attached to the Inferior Dental nerve; and then the Chorda Tympani† in juxtaposition with the Gustatory nerve, each making for the external extremity of the broken condyle: and lastly, the Buccal branch of the Inferior Maxillary nerve, coursing from the direction of the posterior molars of the upper jaw, back between the two bellies of the External Pterygoid muscle towards the antero-internal aspect of the fractured condyle.

The Student will now *pursue the Chorda tympani to the Skull.* He will find it leave the posterior side of the Gustatory nerve at a point a little before this last nerve crosses internal to the Inferior Dental nerve: and then pass internal to the Inferior Dental, and Auriculo-temporal nerves, to reach the skull by an aperture at the inner end of the Glasserian fissure, *i.e.* that fissure which separates the articular part of the glenoid-

* Some anatomists consider Portio dura = vii.; and Portio mollis, or auditory, = viii. cf. p. 238.

† By means of the Chorda Tympani the Gustatory nerve is put in relation with the Facial nerve: and it is also in communication with the Hypo-glossal nerve by means of the plexus which its own branches form with branches of the Hypo-glossal nerve at the inner border of the Hypo-glossus muscle.

fossa (on which rests the cartilaginous disc) from the remaining part behind, which is formed by the Tympanic subdivision of the Temporal bone. The rest of the course of this nerve lies within the Ear: it leaves the trunk of the Facial while within its canal, enters the back part of the tympanic cavity through a short canal close to the membrane of the Tympanum, and crosses this membrane and the handle of the Malleus to gain the aperture above noted at the inner end of the Glasserian fissure. Its after course, as we have seen, is downwards and forwards under cover of the posterior belly of the External Pterygoid, internal to the Auriculo-temporal and inferior Dental nerve, to unite with the Gustatory nerve at an acute angle: with this nerve it ascends, in close contact, to a point about opposite the posterior molar teeth, then curves downwards and backwards to the sub-maxillary ganglion, and along the course of the duct of the sub-maxillary gland to the second factor of the ganglion near the gland, and there it becomes too fine to trace its terminal twigs.

Next let him *take the posterior belly of the External Pterygoid with the inner angle of the condyle of the jaw attached to it, and pass it, beneath the internal maxillary artery, forwards between the Buccal and Gustatory nerves,* in order to expose the junction of the four great branches of the Inferior Maxillary subdivision of the Trifacial, *viz.*, the Buccal, Gustatory, Inferior Dental, and Auriculo-Temporal: these may then be traced up to the skull and cleaned; and the united trunk noted to perforate the skull at a point a little anterior and internal to the site of the temporo-maxillary articulation. The Foramen thus arrived at, inasmuch as it transmits the third or inferior division of the Trifacial, is homologous with the so-called foramen ovale of the human skull.

DISSECTION OF INTERNAL PTERYGOID NERVE; EUSTACHIAN TUBE; AND OTIC GANGLION.—Having thus two fixed points to start from, *viz.*, the Chorda tympani and the united Inferior

Maxillary, we may, by careful investigation of the intervening area, arrive at the ***Eustachian tube, and Internal Pterygoid nerve.*** Just at the point where the Auriculo-temporal nerve runs in to the main trunk, but internal and posterior to it, will be found the short branch of the Internal Pterygoid nerve leaving the Inferior Maxillary to penetrate the Internal Pterygoid muscle; when this is cleaned there will be seen underlying it, at a slight angle, a small strip of muscle; and between this strip of muscle and the Inferior Maxillary root a bluish hard tube will be readily distinguishable, which is the proximal end of the Eustachian tube, *i.e.*, the canal which leads from the cavity of the tympanum to the upper part of the Pharynx.

The Eustachian tube and Internal Pterygoid nerve thus found, give us the bearings of the anterior portion of the diffused *Otic ganglion.* This ganglion is of a reddish-grey colour, and situated on the deep surface of the Inferior Maxillary trunk, around the origin of the Internal Pterygoid branch. Its inner surface is close to the cartilaginous part of the Eustachian tube. It is perhaps best seen by pressing back the united Gustatory and Inferior Dental branches: the ganglion occupying the apex of a triangle of which these nerves form the left side, the Buccal nerve the right side, and the Internal Maxillary artery the base.

The *Facial branch of the seventh nerve may be now cleaned up to the skull, i.e.* to the Stylo-mastoid foramen, situated between the Paroccipital process, the external auditory meatus, and the commencement of the Stylo-hyoid chain of bones and ligaments.

The large compressed Stylo-hyal bone may be now cleaned at its proximal end, and the prominent posterior process exposed: the normal anterior boundary being traced up internal to the Parotid gland and Carotid artery (which should both be slightly turned over to the front) to its short

ligamentous attachment, a little anterior and inferior to the Stylo-mastoid foramen whence issues the seventh nerve.

Removal of Part of the Cranial Wall in order to expose the Root of the Trifacial Nerve.—It will be well, before making the above dissection, to gently press away from the cranial wall with the handle of the scalpel, the portion of brain thereto adjoining, in order to see clearly the origin of the cranial nerves in that part. In this way there will be seen beneath the Cerebellum two stout nerve roots leaving the Medulla, just opposite the external auditory meatus; of these, that directed forwards is the root of the Trifacial, and that directed straight outwards is the Seventh nerve. Posteriorly is seen a group of nerve fibres, mainly directed outwards; these constitute the group sometimes called the Eighth Nerve*; but which really consists of three distinct nerves: the Glosso-pharyngeal, Pneumo-gastric, and Spinal Accessory: the two first of these being attached to the Medulla Oblongata in the same line; the last, the Spinal Accessory, taking its origin chiefly from the spinal cord, and coming forward to join the Pneumo-gastric in the foramen of exit, called the jugular foramen. Lastly, anteriorly to the Trifacial will be seen two fine nerves, one arising from the Valve of Vieussens, between the Cerebrum and Cerebellum, and extending forwards in the Dura Mater in the same direction as the main bulk of the Trifacial, *viz.*, the Fourth Nerve (pathetic, or trochlear); the other, coming from the Cerebrum and directed obliquely outwards, being the Third Nerve, or motor oculi.

The Student will now take a saw, and make *two* incisions in a general direction from the middle of the Brain to the root of the Tongue. Of these the anterior should be taken just behind the orbital ring, through the middle of the anterior

* According to another arrangement, in which the Cerebral nerves are reckoned as *twelve pairs*, the Glosso-pharyngeal = ix.; the Pneumo-gastric = *x.*; and the Spinal Accessory = xi.

belly of the external pterygoid; in other words, through the Frontal, anterior margin of Parietal, and Sphenoid bones, in the direction of the sphenoidal fissure; and here care must be taken not to saw through too deep, or otherwise the second subdivision of the Trifacial, which goes horizontally forwards from the sphenoidal fissure, *viz.*, the Superior Maxillary subdivision, will be injured or even cut through. The posterior incision should be made on a line drawn from a point about two inches in advance of the posterior margin of the occipital condyle, through the glenoid fossa, down to the upper surface of the Inferior Maxillary nerve; in other words, from the upper margin of the occipital bone to the foramen ovale, keeping clear of, and to the front of the external auditory meatus and glasserian fissure, so as to leave the Chorda tympani uninjured. Neither of these incisions should be carried with the saw quite down to the points indicated; but when within a short distance thereof, a few strokes with the mallet on the outer table of the part to be removed, will complete the fracture along the line of the foramina required; and then by carefully scraping the dura mater from the inner surface of the bones with the scalpel, the portion of the cranial wall may be removed without injury to the nervous structures lying just within.

Removal of Posterior Margin, and Superior Internal Wall of Orbit, and Dissection of Orbital Membrane and Lachrymal Gland.—*Three cuts should be made with the saw;* one just below the junction between the frontal and malar bones; a second a little distance, about three-eighths of an inch, above this point; and a third along a line drawn from the anterior margin of the orbit to the Optic nerve where it leaves the skull through the optic foramen. This last incision must not be made too near the middle line of the skull or the pulley of the superior oblique muscle will be destroyed. The Student, with the skull before him, will bear in mind through

how much bone he will have to saw in each case, and will take care not to cut too deep; to avoid which, it is always best to finish the fracture by the introduction of a chisel into the groove made, and forcing the crack by a sort of lever action on the bone surfaces. The *two pieces of bone included between these three incisions should be removed* after that the contents of the orbital cavity have been detached from all connection with their inner surface. Special care will be needed as the dissector approaches near to the optic foramen, to avoid injuring the Fourth nerve.

The Orbit contains the following structures within the orbital membrane, *viz.*: the Eyeball, the Lachrymal, and Harderian glands; six muscles connected with the eye—four straight and two oblique: and one muscle connected with the upper eyelid: also numerous nerves, *viz.*, the Second, Third, Fourth, Ophthalmic division of the fifth, and the Sixth, with part of the Sympathetic: and, lastly, the Suspensory (or Choanoid) muscle.

Some of the mass of fat which fills up the lower part of the orbital cavity may be removed, care being taken not to cut down on the Superior Maxillary branch of the Fifth nerve, which runs horizontally forward from the inferior limit of the sphenoidal fissure.

It will then be found that the lower part of the orbit, which is completed in Man by an osseous framework, is here only completed by membrane. This membrane is the orbital membrane or periosteum, which thus becomes a structure of much importance, for it stretches across the floor of the orbit from its outer to its inner wall, extends backwards to the optic foramen, and completes the boundary of the cavity at the spot where the bony wall is wanting. Intimately connected with the membrane, and forming an essential part of it, is a thin layer of a pale-reddish substance, which extends across the greater part of the floor of the orbit, passing backwards

to the optic foramen and sphenoidal fissure. This reddish mass* may be seen under a quarter-of-an-inch object glass, to be composed for the most part of flat, pale, non-striped fibres, collected together in bundles, with which is mingled both white and yellow ordinary fibrous tissue: the pale non-striped fibres having all the characters of the involuntary muscular fibre. By irritation of the cervical sympathetic, these membranes project the contents of the orbit, especially the bulb, forwards. Retraction is produced by the transversely-striped 'retractor'. In Man, the orbital membrane is much reduced in size, and the 'retractor' is wanting, so that no distinct projection of the bulb follows irritation of the sympathetic†.

The pink glandular mass, situated in the upper and back part of the orbit, is the *Lachrymal gland,* which secretes the tears; it resembles in structure the salivary glands; and has numerous fine ducts which open on the inner surface of the upper eyelid. As the eyelids are generally removed with the skin before the head is sent in to the market, their arrangement can only be seen in a specimen specially reserved.

Removal of Orbital Membrane and Dissection of the Nerves, Ganglion, and Muscles contained therein.—*The orbital membrane should be now divided towards the back of the orbit, and taken away;* and then the fat internal to the membrane carefully removed: by this means the fine *Fourth nerve,* which was traced before along the commencement of the Ophthalmic branch of the Fifth nerve, may be followed up to the inner side of the orbital cavity, and to its termination in a muscle there situated. This muscle, by the entrance of the Fourth nerve into it, is recognised as the Superior Oblique muscle. It will be seen that the Fourth

* If specially prepared by soaking in diluted nitric acid.
† Turner (Edinburgh), *Natural History Review,* January, 1862; and *Strangeway's Veterinary Anatomy,* p. 475.

nerve enters the *orbital surface* of the muscle, and not the ocular surface, as is generally the case with the other nerves. In close apposition with the Superior Oblique muscle will be seen the most superficial of the muscles of the orbit, *viz.*, the *Levator Palpebræ Superioris,* in contact with the periosteum externally, and the Superior Rectus internally: it will be seen, later on, to arise close to the optic foramen, and may be now traced forwards to its insertion into the forepart of the tarsal cartilage of the eyelid.

The Fat should be cleaned away round the *Superior Oblique* muscle, and it will then be seen to be a thin and narrow muscle arising from the outer end of the optic foramen, and passing through a fibrous loop at the upper internal surface of the orbit, before being *inserted* into the sclerotic coat behind the middle of the eyeball. The pulley, or *trochlea,* consists of a fibro-cartilaginous ring, attached by fibrous tissue to a small tubercle on the frontal bone at the supero-internal aspect of the orbit. The thin insertion of the muscle passes internal to the superior rectus muscle, and terminates between this and the external rectus.

The *Superior Rectus* muscle should be next cleaned out (the upper one of the two just noted), and its origin from the outer margin of the optic foramen, where it is connected with the other recti muscles around the Optic nerve, noted.

At this point it will be advisable to trace the anterior termination of the Lachrymal and Supra-orbital branches of the Ophthalmic division of the Fifth nerve. The Ophthalmic, the smallest of the three great divisions of the Fifth, is divided in the Sheep into two principal branches: one, the smaller, going towards the back; the other, the larger, going towards the inner front of the orbit. Of these, the first is made up of two principal factors, *viz.*, a Lachrymal and Supra-orbital branch; the second enumerates but one factor, the Nasal branch. The *Lachrymal* and *Supra-orbital* branches lie just within the

orbital membrane on the outer margin of the orbit; united at the origin of the principal muscles of the eye, they proceed about three-quarters of an inch further together, ascending along the direction of the most external muscle of the eye, *viz.*, the external rectus, and then they part company; one small twig passing straight up to the Lachrymal gland, the other continuing on in its first direction, to be distributed to the muscles and integument on the superior and posterior margin of the orbit. Of the *Nasal branch we shall treat later on.*

The tendinous insertion of the superior rectus into the sclerotic coat beneath the lachrymal gland should be next noted. The inner surface of this muscle is in apposition, near its insertion, with the suspensorius muscle (found in all Quadrupeds up to the Quadrumana), and with the tendon of the superior oblique; and, near its origin, with two stout nerves, *viz.*, the Third, by which it is itself supplied, and the Nasal branch of the Fifth. A twig from the fifth will also be found supplying this muscle.

The *External Rectus* muscle may be next cleaned. This muscle has a similar origin and insertion to the Superior Rectus, *but* is supplied by a separate nerve, the Sixth nerve,—a very fine thread, which reaches the muscle near its origin, and on the edge nearest to the Superior Rectus.

Factors of the Pedicle of the Eyeball.—We have now, at this stage of the dissection, disclosed the following factors of the stalk, or pedicle, of the eyeball:—nearest to the middle line is the tiny Fourth nerve; next to it the origins of the levator palpebræ superioris, and superior rectus muscles; then the Third nerve, the Nasal branch of the Ophthalmic division of the Fifth nerve, the twig from the Fifth supplying the superior rectus, and the Sixth nerve, all occupying the narrow slit between the origin of the rectus superior, and that of the rectus externus, which comes next; and lastly,

most externally, the Lachrymal and Supra-orbital branches of the Ophthalmic division of the Fifth nerve.

The orbital membrane may now be further reflected on the outer side, and the fat carefully removed; by which means the origin of the inferior rectus will be disclosed, adjoining that of the external rectus; and between the edges of these two muscles will be seen a stoutish nerve running forwards, and a thin nerve running backwards, both meeting at a spot about half an inch from the origin of the muscles. Of these two nerve-cords,—that running forwards is the continuation of the Third nerve, and that running backwards is a factor from the Fifth nerve, *en route* to the Ciliary ganglion.

The Student should now carefully separate the contiguous margins of the superior and external recti muscles; turn each away from the other, and remove the fat.

The further course of the Nasal branch of the Ophthalmic division of the Fifth nerve will then be made out, tending inwards across the stalk of the Choanoid or Suspensorius muscle, and then across the origin of another muscle arising close to it, *viz.*, the internal rectus. Arrived at this point, the nerve will be found to bifurcate,—one branch, after gaining the anterior edge of the superior oblique muscle (between which and the internal rectus it has just passed,) re-enters the cranial cavity through a foramen in the orbital plate of the frontal bone, to pass through the cribriform plates of the Ethmoid bone, and be distributed on the walls of the nasal fossæ:—the other branch continuing further forwards to the margin of the orbit, to be distributed to the lachrymal sac, eyelids, and side of nose.

If now the stalk, or origin of the suspensorius, be gently pushed on one side away from the superior rectus, the large white *Optic nerve* will be brought into view, and a little *more of the course of the Third nerve, viz.*, where it dips under the pedicle of the Suspensorius in company with the Optic nerve.

At this point the Third nerve will be found to send off a branch tending to the inner aspect of the orbit, to supply the inferior rectus muscle; the main stem continuing rather towards the outer side of the eyeball.

It will next be well to gently separate the suspensorius from the external rectus: these two muscles will be found intimately united at their origin; and more, they are both supplied by filaments from the same nerve, *viz.*, the Sixth.

Dissection of Lenticular or Ciliary Ganglion.—We previously directed attention to the line of demarcation between the superior and external recti muscles: it will now be well to separate their apposed edges in the same way that the others have been treated: only in this case with more care, for, within their lips, where the two different nerves seem to converge, will be found the *Lenticular or Ciliary ganglion*, a knot of nervous matter, not very readily distinguished from the surrounding fat, except by its slightly reddish tint. In situation it may be described as occupying the centre of a triangular cavity enclosed by the Optic nerve, and the external rectus, and suspensorius muscles. By its inferior border, the ganglion will be seen to have branches of communication with other nerves; and in the ganglion sensory, motor, and sympathetic filaments are combined. A short thick branch passes from its lower margin to join the branch of the Third nerve, which is now seen to continue forwards towards the anterior external boundary of the orbit; and a second branch, or rather main factor, comes from the Fifth; it is also connected with the sympathetic system by a nerve emanating from the cavernous plexus of the Sympathetic. From the superior border of the ganglion proceed two branches, each of which consists of a bundle of small twigs; these extend along the Optic nerve to the eyeball, which they enter by apertures in the back of the sclerotic coat; and are

eventually lodged in grooves on the inner surface of the sclerotic, pierce the ciliary muscle, and ramify in the Iris.

The Third nerve should now be traced forwards; first along the posterior edge of the inferior rectus, then across the outer surface of the upper part of this muscle, to terminate in the *Inferior Oblique muscle.* This muscle is situated near the anterior margin of the orbit, and differs from the other muscles in being directed across, instead of parallel to, the axis of the orbit. It *arises* from the lachrymal bone, immediately beneath the lachrymal duct. From this spot the muscle passes outwards above the internal rectus, and between the suspensorius and external rectus, to be *inserted* into the upper margin of the sclerotic coat at this point, close to the insertion of the superior oblique muscle.

The next stage of the dissection requires very great care, *viz.*, in tracing back the several nerve branches above enumerated through the dura mater and upper part of the cavernous sinus to the Brain.

The Cavernous sinus is so named from the reticulate structure in its interior; the space results from the separation of the layers of the dura mater. The piece of dura mater bounding the sinus externally is of some thickness, and contains *in its substance* the following nerves. The most superficial is the Fourth Nerve: it lies almost on the surface of the internal aspect of that ridge of the dura mater which passes along the tips of the clinoid processes: next below it, is the Third Nerve; and below this, again, the two quite distinct though apposed branches of the Ophthalmic division of the Fifth Nerve. Through the *cavity* of the Cavernous sinus the Sixth Nerve passes.

It will require considerable patience to trace these nerves, and the dura mater in which they are imbedded should be kept moist during the dissection by applying a damp sponge.

To complete the dissection of the Orbit there only remains

the investigation of the Membrana Nictitans, and its accompanying gland, *viz.* the Harderian Gland.

In tracing back the Inferior Oblique muscle to its origin below the Lachrymal duct, a light pink gland will have been noted in the interval between the Inferior and Internal Recti, and the Inferior Oblique muscles: this is the Harderian gland, by which a thick whitish humour is secreted. Associated with this gland, in the angle of the eye, between the globe and the side of the orbit, will be found the accessory eyelid or Membrana Nictitans, a fibro-cartilaginous structure continuous posteriorly with the pad of fat which is insinuated between all the muscles of the eye. When the eye is in its natural position the margin of this membrane is only to be seen, the rest being buried in the ocular sheath; but when by the contraction of the Recti and Suspensorius muscles, the globe of the eye is drawn back against the pad of fat, the membrane protrudes across the eye. The secretion of the Harderian gland is poured forth from two openings under the Membrana Nictitans, in order to facilitate the motion of this membrane over the eyeball.

NERVES OF THE ORBIT.

Eyeball	is supplied	by	Second Cerebral	(sensory).
Levator Palpebræ	,,	,,	Third Cerebral	(motor).
Rectus Superior	,,	,,	,,	,,
Rectus Inferior	,,	,,	,,	,,
Rectus Internus	,,	,,	,,	,,
Obliquus Inferior	,,	,,	,,	,,

(*i.e.* the Third Nerve supplies all but three of the muscles of the eye)

Obliquus Superior is supplied by Fourth Cerebral (motor).

Fore-part of the Head, Nose, and Lachrymal Gland	,,	Fifth Cerebral, Ophthalmic Division (sensory).

Rectus Externus is supplied by Sixth Cerebral (motor).

Choanoid or Suspensorius	,,	,,	,,

The position of the parts in the Orbital Cavity may be shortly reviewed as follows:—The Supra-orbital and Lachrymal nerves lie close to the outer wall of the cavity; and the small Fourth nerve near the inner wall: *all entering the Orbital cavity above the muscles.* The Superior Oblique muscle is recognised by the Fourth nerve entering it: the Levator Palpebræ and Superior Rectus are crossed by the Fourth nerve: the External Rectus is seen between the Supra-orbital and the Lachrymal nerves.

A small nerve, the Temporo-malar, or *orbital branch of the Superior Maxillary* trunk, lies in loose fat, along the outer angle of the floor of the orbit, and should be traced before further dissection is made in that part, as it is soft and easily broken: it is distributed to the eyelids and to the integument.

Dissection of Spheno-Palatine Ganglion.—The Periosteum, or Orbital Membrane, should now be dissected away from the subjacent fat, and, together with the contents of the orbit,turned towards the top of the skull; and the fat removed.

By this means the cancellous bony structure that projects backwards along the base of the orbit in the direction of the optic nerve will be disclosed; and, immediately beneath it, the Superior Maxillary division of the Fifth nerve: this stout bundle of nerves should be traced back to the Gasserian ganglion, and forwards to the point where it enters the maxillary hiatus to pass through the infra-orbital canal and emerge on the face at the infra-orbital foramen, where it divides into numerous branches. In the orbit this nerve is accompanied by the internal maxillary artery.

Internal to the Superior Maxillary Branch, and between it and the nerves to the Eye will be found the much diffused *Spheno-Palatine Ganglion,* also known as Meckel's Ganglion. The junction of the Orbital branch with the Superior maxillary division takes place about the middle of the ganglion.

The ganglionic mass is of a reddish grey colour, but is not easily distinguished from the surrounding fat; this ganglion resembles the other ganglia in connection with the Fifth nerve, in having sensory, sympathetic, and motor roots connected with it. Its motor root is formed by the Vidian nerve, which does not here run in a separate osseous canal as it does in Man, and so may be traced, as the principal branch, back as far as the under or internal aspect of the Fifth nerve; beyond this point it is not easily traced, but its course may be here noted,—through the back part of the cavernous sinus to the superior cervical ganglion, which will be exposed later on, hidden now by the par-occipital process and the muscles thereto attached. The emergent branches of the Spheno-palatine ganglion are distributed to the muscles and vessels of the orbit, to the soft and hard palate, and to the nose.

Close adjoining the line of the Spheno-palatine ganglion and its several cords, is the line of the Dental nerve, which quits the main trunk of the Superior Maxillary soon after it leaves the Gasserian ganglion, passes along the floor of the orbit, enters a canal in the maxilla, and then supplies the teeth. We have now traced the principal branches of the Fifth nerve, as follows:—

Fifth or Trigeminal or Trifacial Nerve.	*Sensory root,* through Gasserian Ganglion to all three divisions. *Motor root.* Inferior Maxillary division alone.	Ophthalmic division (with Ciliary ganglion).	Supra-orbital, to forehead.
			Lachrymal, to l. gland and eyelid.
			—Nasal, to nose & eyelid
		Superior Maxillary division (with Spheno-Palatine Ganglion).	—Orbital, to eyelid and side of face.
			—Infra-orbital, to lower eyelid, side of nose, and upper lip.
			—Dental, to teeth of upper jaw.
		Inferior Maxillary division (with Otic & Submaxillary ganglia).	Buccal, to cheek and angle of mouth.
			Auriculo - temporal: through parotid gland
			Gustatory or Lingual, to tongue.
			Inferior Dental, to teeth of lower jaw, lip, and chin.
			Mylohyoid, to Mylohyoid muscle.

Dissection of the Eighth and Ninth Pair of Cerebral Nerves, and of the Sympathetic System at the base of the Skull.—The Student will first cut through the par-occipital process near to the Skull, and turn it forwards, and fix it in that position with a set of hooks and chains: by this means he will be enabled to get at, and dissect out, the bundle of nerves that lie but little below the fat in the cavity between the par-occipital process and the external aspect of the occipital condyle.

This bundle of nerves consists of, in order from back to front, the following principal factors:—the Ninth or *Hypoglossal Nerve* leaves the skull through the anterior condyloid foramen, and is crossed at about $\frac{1}{2}$*in.* from the foramen by the *Spinal branch of the Spinal Accessory;* this spinal branch joins the course of a stout nerve called the *Pneumogastric* or *Vagus* just before it crosses the Hypo-glossal, and these may be traced back together to the 'foramen lacerum basis cranii,' by which they take exit from the skull. Next adjoining this stout nerve-branch is the fine *Glossopharyngeal Nerve,* which leaves the skull at the same spot with the Vagus; and then lies along the external surface of a nodulation of a pinkish hue; this nodulation is the *First Cervical Ganglion of the Sympathetic System.*

But in order to get at the roots of these nerves it will be necessary to take the saw and first cut through the occipital condyle down to the condyloid foramen, and break it off with the chisel, thus exposing the root of the Hypo-glossal nerve; and, secondly, to saw down from the posterior side of the Facial nerve to the cranial exit of the conjoined Eighth pair of nerves, separate the grooves with the chisel, and then cut through the remaining pedicle of bone with the bone nippers, by which means the ganglia at the root of the Eighth pair of cranial nerves will be disclosed. It will now be well *to trace* each of these nerves forwards.

The *Hypo-glossal* is a motor nerve; after passing from the cranium by the condyloid foramen, it crosses first the Vagus (being embraced between it and the spinal branch of the Spinal Accessory), and then the carotid artery; near this point it gives off a branch, the *descendens noni*, which descends in the sheath of the carotid artery, and is distributed to the depressor muscle of the os hyoides. The further prolongation of the main stem of the Hypo-glossal to its disappearance beneath the mylo-hyoid muscle has been traced in a previous dissection (p. 231).

The *Spinal Accessory* is a motor nerve; its origin from the cervical portion of the spinal cord, and entrance into the cranium by the foramen magnum was noted above: after leaving the cranium through the foramen lacerum it divides, the Accessory part gives twigs to the Vagus, and the Spinal part continues backwards under the superior extremity of the submaxillary gland, passes down the neck, supplies the Sterno-mastoid muscle, and is lost in the Trapezius muscle.

The *Pneumogastric* or *Vagus* is a mixed nerve, originating by motor and sensory roots, and is the largest of the cranial nerves in the neck. In its passage through the foramen lacerum in the same sheath of dura mater with the Spinal Accessory, it has developed a distinct ganglion, termed the *ganglion of the root;* and after it has escaped from the foramen, and received the Accessory part of the Spinal Accessory, it presents a second and fuller enlargement, termed the *ganglion of the trunk:* it then descends behind the guttural pouch, and proceeds down the neck in the same sheath with the common carotid artery.* The principal branches in the upper part of its course, near the head, are two, *viz.*, (1) a *Pharyngeal branch,* which comes off near the ganglion of the trunk and

* The further course of this nerve has been previously seen in the dissection of the Rat.

Basioccipital, Basisphenoid, Presphenoid, and Ethmoid; the roof being formed by the Frontal, Parietal and Supraoccipital, which have been cut away. The Ethmoid bone consists of two perforated parts and a median partition, the perforated parts being opposite to, and transmitting the olfactory nerves arising from the olfactory lobes. That which comes into view under the vertical section is the middle plate, or 'lamina perpendicularis' of the Ethmoid bone; and its prolongation forwards, as the median cartilaginous septum of the nose. Considering this septum to be a continuous structure, ossified in the neighbourhood of the cribriform plates, but not ossified beyond the first inch and a-half from the cranium, Professor Flower applies the term '*Mesethmoid*' to the whole of this element of the skull, whether ossified or not, including the 'crista galli' of human anatomy. On either side of this Mes-ethmoid are the Turbinal bones, contained in either nasal cavity. These Turbinals are formed by two distinct sets of convoluted spongy bony plates; a lower set, which come close down to the nasal orifice, and which are attached to the Maxilla by one of their folds, whence they are called *Maxillo-turbinals*, and an upper set, extending from the cribriform plate to the posterior and superior margin of the Maxillo-turbinals, from which however they are quite distinct and separate, and called, from their attachment to the cribriform, ethmoid, or sieve-like plate, the *Ethmo-turbinals*. "It will be observed* that while the Ethmo-turbinal is placed high in the nasal cavity, and above the direct channel by which the air passes to the posterior nares, the Maxillo-turbinal, situated near the front of the chamber, before it has divided into an upper true olfactory chamber and a lower nasal passage, nearly blocks up the whole cavity, so that air passing through in inspiration is filtered between

* Flower. Ost. Mam. p. 108.

DISSECTION OF MOUTH, TONGUE, PALATE, POSTERIOR NARES, PHARYNX AND LARYNX.—The Student should now take a saw, without a back, and make an antero-posterior vertical section of the Head; carrying the incision right through the base of the Skull down to the level of the posterior part of the Thyroid Cartilage and the dorsum of the Tongue. The two halves may then be laid out on each side, like the leaves of a book, leaving the Tongue in the middle line.

The osseous frame-work, within which are contained the several parts and organs next to be described, demands the first attention. The upper part of the cranium, or brain-case, was removed in an early stage of this dissection; but the longitudinal central axis, above which are the brain, nose and face, and below which are the posterior nares and the palate, still remains. Posteriorly, and forming the support of the Medulla Oblongata, will be seen, in section, the anterior boundary of the foramen magnum, formed by the *Basi-occipital* factor of the occipital bone; this is about an inch long: then follows the 'body' of the sphenoid bone, or *Basi-sphenoid*, limited anteriorly by a suture (in appearance a greyish line), and hollowed out superiorly to receive a pink oval body: the hollow is known as the *sella* turcica: the pink oval gland depending from the brain, just posterior to the Optic commissure, is the *pituitary body*. Next, anteriorly, is a rather broader bone, notched superiorly by the groove in which is lodged the optic commissure; and terminated anteriorly by the upright perforated bone through which the olfactory nerve fibres penetrate; this is the *Pre-sphenoid*. The Basisphenoid and Presphenoid form in man two of the factors of the 'Sphenoid bone.' The anterior boundary of the cranial cavity is formed, as just said, by the perforated Ethmoid bone, and next above that come the cells in the Frontal bone. Thus the floor of the Cranial cavity is seen to be made by the following bones, arranged serially, *viz.*,

this process that the tendon of the tensor palati muscle passes; a muscle that fixes and renders tense the lateral parts of the soft palate.

Tracing the edge of this bone backwards, a small lip will be found, in the mucous membrane, covering the termination of a tube. This tube, which is closely united to the pterygoid plate, covered by the mucous membrane, and opens into the Pharynx, is the *Eustachian* tube, a canal by which the cavity of the tympanum is rendered continuous with the cavity of the Pharynx; in other words, a canal by which the tympanic cavity of the ear communicates with the external air. The upper part of this canal was noted in a previous stage of this dissection (p. 237).

The *Pharynx* is that cavity that extends obliquely downwards and backwards above the velum palati (which separates it from the mouth), and forms the backward prolongation of the posterior nares. We have just noted the slit-like openings of the Eustachian tubes on each side; below these we come to the *Isthmus of the Fauces*, a narrowed channel between the Pharynx and the mouth, or rather between the free border of the velum palati and the Epiglottis, whose size is altered by the elevated or pendent position of the soft palate.

The posterior border of the soft palate in man presents in the centre a conical pendulous body called the Uvula, but this is absent in nearly all other animals. In the Horse, the velum palati is so much developed that the isthmus is kept constantly shut, except during the passage of food or water, and the animal is unable to breathe through his mouth;* but in the Sheep it is not so complete and pendulous, consequently the isthmus is generally open, thus allowing the animal both to breathe through the mouth and to regurgitate its food in the act of rumination.

* Strangeways.

The anterior and inferior surface of the velum forms the posterior boundary of the mouth, and is united laterally to the base of the tongue. Between the velum and the base of the tongue are two lateral spaces, in each of which are two or three openings, the mouths of the ducts from the *Tonsils*, each tonsil being a collection of follicular capsules.

The *Hard Palate*, or anterior part of the roof of the mouth, consisting of the palatine bones and palatine processes of the superior maxilla, is covered by a dense membrane, equally divided by a median longitudinal ridge, which terminates anteriorly in a small tubercle. From this ridge proceed transverse ridges, dividing the palate into a number of superficial folds, the edge of each posterior fold underlying the posterior margin of the fold next in front of it, so that an abrupt edge is always presented towards the back of the mouth.

The Tongue* presents three distinct portions; the most anterior constitutes the tip, and its upper surface may be called *dorsum planum:* this portion is limited abruptly posteriorly by the hump or elevation which forms the second portion, and whose upper surface may be denominated *dorsum gibbosum:* that part which gradually declines to the base of the epiglottis forms the third part, and its surface may be called *dorsum radicis.* The tip assists in the prehension and mastication of the food; the gibba, like a piston, pushes the bolus towards the pharyngeal cavity; while the root, by means of the exterior parts of its muscles, enables the organ to move as if connected by a joint to the hyoid bone.

In the Human tongue the whole ante-gibbous portion is deficient: it is therefore truncated as compared with the Ruminant tongue. It is by means of the ante-gibbous portion of the tongue that quadrupeds lap up water.

The under surface of the tongue is connected laterally to

* Cf. J. Zaglas. *Annals of Anat. and Phys.*, 1850. Parts i. and ii.

the lower jaw by the genio-hyo-glossi muscles, in front of which the mucous membrane beneath the tip forms a fold called the *Frænum Linguæ*. A little anterior to the frænum on either side are the openings of the ducts of the sub-maxillary and sub-lingual glands.

The upper surface or dorsum of the tongue is covered with papillæ of various form throughout its whole extent, except in the neighbourhood of the epiglottis. *Four varieties of papillæ* are found, *viz.* (*a*) *circumvallate, i.e.* papillæ resting in cup-like depressions of the mucous membrane; these are found only along the lateral margin of the gibbous portion of the tongue; (*b*) *fungiform, i.e.* larger processes of the mucous membrane than the circumvallate, wider at the free end than at the part fixed to the tongue; these are more numerous than the circumvallate, and are principally situated in the middle of the dorsum; (*c*) *conical, i.e.* small cones like white specks, principally along the sides of the tongue; and, lastly, (*d*) *filiform, i.e.* hair-like processes of the epithelium, sloping generally towards the back of the mouth; these papillæ cover the anterior two-thirds of the tongue and vanish towards the base.

Behind the Tongue and in front of the orifice of the Larynx is the leaf-shaped cartilage, termed the Epiglottis; which during respiration is placed vertically, but during deglutition takes a horizontal position so as to close the opening of the Larynx and prevent food passing into it during its passage through the Pharynx into the Œsophagus.

The rounded eminences posterior to the Epiglottis, and on which the Epiglottis rests when depressed backwards, are the Arytenoid Cartilages.

Dissection of the Larynx.—The Œsophagus, which lies above the Larynx and Trachea, should be now dissected away from the Trachea, in order to enable the Student to expose the internal arrangement of the Larynx by a longitudinal cut

with the scissors between the arytenoid cartilages through the tracheal rings and cricoid cartilage.

The base of the Epiglottis will then be seen to be attached to the upper margin of the thyroid cartilage, the largest of the cartilages of the Larynx, and which consists of two lateral expansions or alæ, which meet and unite anteriorly at an acute angle, forming a projection answering to the 'Adam's Apple' in Man.

The upper Vocal Chords are small and inconspicuous. The Tracheal rings are complete, but not absolutely joined, the division being traceable all down the right side.

By pressing outwards the mucous lining of the upper part of the Larynx between the Arytenoids and the base of the Epiglottis, a hard substance will be felt holding an antero-posterior direction: this is the Thyro-hyal bone.

Dissection of the Hyoid Bones.—Without going into the detail of the muscles, the Student should acquaint himself with the position of the series of Hyoid bones, of which the Thyro-hyal is the posterior.

Turning the side of the head up again, he will find this bone almost underlying the tendinous part of the di-gastric muscle, parallel with which it continues for about an inch; at this point, and underlying the Hypo-glossal nerve, a joint will be found; as also what appears to be a single bone (running at right angles to the Thyro-hyal, prolonged a little way down and continuing up towards the last molar of the upper jaw), but which really forms two of the factors of the arch, the downward prolongation being a small round nodule representing the basi-hyal, and the upward prolongation being the cerato-hyal. At the upper end of the cerato-hyal will be found another bone running towards the stylo-hyal; this is the epi-hyal, and thus the ↳ of the hyoid arch is completed,—the top of the ↳ being attached to the Skull, the convexity of the bend supporting the Tongue, and the return end supporting the Larynx.

As before noted (p. 228), the bones follow one another thus: stylo-hyal, epi-hyal, cerato-hyal, and thyro-hyal; the basi-hyal forming an angular prominence between the thyro- and cerato-hyals.

V.—DISSECTION OF THE EYE OF THE OX.*

External.—To see the general form of the ball of the Eye, and the outer surface of the external coat, the attachment of the different muscles should be taken away, and the fat removed which surrounds the white chord of the optic nerve: by this means we shall be enabled to see from back to front the following structures: posteriorly, is the *Optic nerve,* attached to the back of the globe but considerably to one side of its axis; next, the *Sclerotic* (σκληρος, hard) coat, *i.e.* the opaque posterior five-sixths of the ball; and, anteriorly, the *Cornea* (*corneus,* horny), *i.e.* the smaller transparent sixth part of the ball. The outer surface of the Sclerotic coat is smooth except where the muscles have been attached. The Cornea and front portion of the Sclerotic are covered by mucous membrane, called the *Conjunctiva,* being the reflected portion of the under lining of the eyelids, much simplified in character; and where the tendons of the four *Recti* expand over it anteriorly, partly covered by the Conjunctiva, a thin tendinous layer is seen, called the "white of the eye." The Cornea is seen to be elliptical, transparent, and convex

* N.B.—A general notion of the structure of the Eye may be gained by pursuing the following shorter method of dissection, *viz.*—

After all the muscles have been removed, pin the Eye to a loaded cork; then place the cork in a deep pie-dish, and fill the dish with water so as to cover the Eye, and proceed to expose the coats of the Eye by a series of windows, thus:

1. Remove about half of the Sclerotic and Cornea: 2. Remove a smaller portion of Choroid and Ciliary processes: and 3. Remove a small portion of the Retina.

By this means all the coats are seen at the same time, and in situ. C. Robertson.

anteriorly, *i.e.* like a watch-glass, and, at the circumference, blended with the Sclerotic coat by continuity of tissue; and will be found to be smooth and firm, though soft to the touch.

On looking into the eye, there will be seen behind the transparent Cornea, a coloured membrane which gives the tint to the eye; it is the *Iris*, and the central aperture by which it is perforated is the *Pupil.* The small bodies situated on the pupillary margin of the Iris are called *Corpora nigra.* The pupillary opening is entirely filled by a portion of the anterior surface of the Capsule of the *Crystalline Lens.* The space, between the Cornea in front and the Lens behind, in which the Iris is suspended, contains a clear watery fluid, named the *Aqueous Humor.* These several parts act as follows: the Cornea transmits, but also deflects (refracts, or bends towards the axis of the cone) the rays of light transmitted; the movements of the Iris regulate the quantity of light admitted to the Lens; the Lens has the power of refracting and causing the convergence of the rays of the cone of light, not only on their entrance from a rarer medium (aqueous humor) into its anterior convex surface, but also at their exit from its posterior convex surface into the rarer medium (vitreous humor).*

Removal of Cornea.†—The Student should now cut with

* *Kirke's Phys.*, Ed. 7, *p.* 647.

† The following mode of operation is suggested in "Gray's Anatomy." In order to separate the Sclerotic and Cornea, so as to expose the second tunic, the eyeball should be immersed in water contained in a small vessel. A fold of the Sclerotic near its anterior part being then pinched up, an operation not easily performed from the extreme tension of the membrane, it should be divided with a pair of blunt-pointed scissors. As soon as the Choroid is exposed, the end of a blow-pipe should be introduced into the orifice, and a stream of air forced into it, so as to separate the slight cellular connection between the Sclerotic and Choroid. The Sclerotic should now be divided around its entire circumference (*i.e.* midway between the Cornea and Optic nerve), and may be removed in separate portions. The front segment being now drawn forwards, the handle of the scalpel should be pressed gently against it at its connection with the Iris, and, these being separated, a quantity of perfectly transparent fluid will escape; this is the aqueous humor. In the course of this dissection, the *Ciliary nerves may be seen* lying in the loose cellular tissue between the Choroid and Sclerotic, or contained in delicate grooves on the inner surface of the latter membrane. P. 556 (Ed. 1858).

the scissors through the Cornea, all round, at its junction with the Sclerotic, and remove the Cornea from the front of the eyeball. On piercing the Cornea the Aqueous humor, above mentioned, will escape from the chamber of which the Cornea forms the outer wall.

The Aqueous humor differs little from water in its physical characters: but it contains a small quantity of some solid matter, chiefly chloride of sodium (in the human subject), dissolved in it.

The Cornea is readily separable into two layers, one fibrous, and the other firm but structureless, retaining its transparency for a long time; of these, the former, made up of a series of fine superposed layers, and lined posteriorly by a very thin structureless membrane, known as the membrane of Demours, is the Cornea proper; the latter, consisting of a basement layer *(anterior elastic lamina)* covered by Epithelium, is the Corneal Conjunctiva. The Epithelium in front of the 'anterior elastic lamina' demands special notice; for in the Horse, the Ox, and the Sheep, it has a much more remarkable appearance than in Man, and one not to be accounted for by the ordinarily presumed mode of growth of stratified epithelia; for the deepest cells are greatly elongated and larger than those which are immediately superimposed, and have precisely the appearance of true columnar epithelium, the flat ends resting on the subjacent elastic lamina, and the pointed extremities directed forwards.*

The *Chamber of the Aqueous Humor*, which has been thus opened into, was formerly said to be partially divided into two chambers which communicated through the Pupil; but it has now been ascertained that in Man the pupillary margin and part of the posterior surface of the Iris are in contact with the Capsule of the Lens, thereby closing the chamber

* Quain and Sharpey, ii. 715 (Ed. 7).

posteriorly. There exists, however, a ***distinct and separate middle chamber***, anterior to the circumference of the Lens (= the *posterior* chamber of old anatomists), *viz.*, in the angular interval existing at the circumference between the ciliary processes, the Iris, and the suspensory ligament of the Lens.

Reflection of Sclerotic.—Let four cuts be now made with the scissors through the Sclerotic from the edge whence the Cornea has been removed, towards the optic nerve—being careful to cut through the Sclerotic alone,—and let the four resulting flaps be pinned down upon a cork so as to support the Eye in an upright position: a thin structure* will be found to unite the fore part of the Sclerotic to the front of the underlying dark tunic called the Choroid; this must be broken through with the handle of the scalpel, as also some connections further back towards the optic nerve.

The Choroid coat, Ciliary (*cilium*, an eyelash) processes, and Iris are supplied by vessels from the *Ophthalmic* (ὄφθαλμος, an eye) *artery*, named the anterior and posterior *Ciliary vessels*: of these the posterior (short) ciliary branches pierce the Sclerotic coat around and close to the Optic nerve: the anterior (long) branches, arising in front of the orbit chiefly from muscular branches, pierce the Sclerotic just behind the Cornea. The Ciliary veins also perforate the Sclerotic at different points to go to join the Ophthalmic veins.

The inner aspect of the Sclerotic coat will be seen to be of a dark colour, resulting from the presence of a delicate connective tissue (*Membrana Fusca*) through which branches of the ciliary vessels pass obliquely: and which is thickest at the back part of the eyeball, becoming thinner and whiter towards the Cornea. On the inner surface of the Sclerotic, at its corneal margin may be seen a circular groove passing round; which

* Vide *infra*, Ciliary muscle.

groove is the outer wall of a venous canal (sinus cir iridis), the *Canal of Schlemm;* the inner wall of this c to be seen on the middle coat of the eye, just with thickest part of the white ring which by the removal Sclerotic coat has been disclosed (around the eye just b the anterior boundary of the Sclerotic). The white rir named marks the ciliary ligament and muscle, which the extent forwards of the black Choroid coat.

The *Ciliary muscle* forms a ring of unstriped muscular f *its fibres are attached in front to the inner surface of the S coat,* and are also connected with the terminal fibres posterior elastic layer of the Cornea. The *Ciliary ligam* ternal to the Ciliary muscle, surrounds the Iris nearly o the junction of the Cornea with the Sclerotic tunic: serve the purpose of supporting the other coats at the fore part of the Eye.

It may now be noted that the *Iris* is connected by its circumferential border with the Choroid, the Cornea, and the Ciliary ligament and muscle; whilst its inner edge is the boundary of the Pupil: its anterior surface is variously coloured.

The outer surface of the *Choroid* is flocculent, and is covered by remnants of a pigmentary areolar tissue (membrana fusca) between it and the Sclerotic coat: in it may be seen small veins arranged in parallel arches (vasa vorticosa); and lying upon its surface are the ciliary arteries and nerves.

Reflection of Half of the Iris.—The student should now carefully lift up a portion of the Iris in the forceps, and with the scissors separate it (for half its circumference), from its attachment along the inner margin of the ciliary muscle, and reflect it.

By this means an anterior view of the *Ciliary processes* may be obtained. These Ciliary processes are a series of plaits or folds, disposed in a circle, and projecting inwards, at the back of the circumferential portion of the Iris; they form the an-

terior termination of the Choroid coat. The plications of the Ciliary processes of the Choroid coat fit into, or interdigitate with corresponding plications of the suspensory ligament of the Lens: this the Student should note carefully before making the following

REFLECTION OF THE CIRCLE CONTAINED WITHIN THE CILIARY RING.—Let the Student divide the Choroid coat, and the Retina which lies beneath it, circularly, with the scissors, about $\frac{1}{4}$-in. behind the white ring of the Ciliary muscle, being specially careful not to cut the Hyaloid* membrane; and raise this piece of Retina and Choroid coat, together with the Ciliary ligament and the attached Iris in one piece; detaching the Ciliary processes of the Choroid coat from the digitations which they form with the plications (also called Ciliary processes) of the suspensory ligament of the Lens; and float this in water over a piece of whitened cork or wax: then gently wash the pigment from the back of the Iris. Great care is necessary to leave the Lens, its capsule, and its suspensory ligament, and the Hyaloid membrane, in situ: but it is of the utmost importance in order to the right understanding of this middle section of the Eye.

We by this means obtain a posterior view of the same ciliary processes of which we have just examined the anterior aspect beneath the Iris.

The posterior surface of the Iris is covered with a deep tinted pigment, called the *Uvea* (*uvea*, a cluster of grapes) from the *purple colour* it assumes in man: after removing this, the membrane of the Iris should be treated with acetic acid, and then there may be seen (under the microscope) at the margin of the pupil a narrow circular band of non-striated muscular fibre (*Sphincter muscle* of Pupil) with which, lines radiating from the centre to the circumference (*Dilator mus-*

* *Vide infra*, Hyaloid membrane, p. 266.

cle) are blended:—there may also be seen prominent festoon-like processes of the fibres of the Iris lying in a transparent, elastic, fibrous tissue continuous with the posterior elastic layer of the Cornea, and giving a milled appearance like that of the edge of a coin; this constitutes the *Ligamentum pectinatum*:—and, lastly, the finely indented border, *ora serrata*, which forms the anterior boundary of the nervous tunic or Retina, extending forwards nearly to the outer edge of the Ciliary processes of the Choroid, whence nucleated, elongated cells (not nerve elements), constituting the *pars ciliaris retinæ*, are continued onwards as far as the tips of the Ciliary processes.

The anterior face of the eye after the performance of the various sections above described (*viz.:* 1. Removal of Cornea, 2. Reflection of Sclerotic, and 3. Reflection of Circle contained within Ciliary Ring) now presents to our view (*a*) a transparent, though firm and elastic *Capsule* encompassing the Lens; (*b*) a transparent membranous structure placed around the Lens, termed the *Suspensory ligament*, or Zonule of Zinn, on which dark lines of pigment covering the surface may be traced, which when washed, reveal plaits or folds less prominent but longer than the processes of the Choroid coat which have been just removed therefrom (these two sets of folds having been dovetailed together, the prominence of one membrane being received into the hollow of the others); (*c*) the fine transparent *Hyaloid membrane* which encapsulates the *Vitreous Humor*, and is at its fore part closely united with the posterior aspect of the suspensory ligament of the Lens, which however it underlies, and, passing beyond, ends by joining the back of the capsule of the Lens: (*d*) the cut edges of the Retina and of the Choroid coats. It will be apparent from the above description that it is possible for an interval to exist, surrounding the edge of the Lens capsule, bounded in front by the suspensory ligament, and behind by the hyaloid membrane (in that it passes posteriorly to the suspensory ligament, though

attached to its outer border, *en route* to reach the Lens capsule). Such an interval does exist, and is known as the *Canal of Petit.*

At this point in the dissection we have then three concentric rings apparent in front of the eye; in the centre, the Lens and its capsule; immediately external to, and placed around the lens capsule comes the transparent, membranous, suspensory ligament of the Lens, and, next, the cut edge of the Retina, of which the anterior termination (ora serrata) was removed in a previous dissection.

The Student should now cut across the thin membranous capsule in which the crystalline Lens is enclosed, and withdraw the Lens (which is a transparent *double convex* body) from its seat in a hollow on the front of the Vitreous body to which it is inseparably united.

The Lens should be dried, or hardened by immersion in spirit*, or boiled† in a test tube until it becomes opaque, and then split with a knife, by which it may be demonstrated to consist of a whole series of concentric laminæ, arranged one within another, like those in an onion, which may be separately detached from one another. Under the microscope each layer may be teased out with needles and seen to be constructed of minute parallel fibres: and in the Lens of the Ox, now under consideration, these fibres in some parts of the Lens will be seen to be irregularly serrated at their edges; but this is not the case in every layer, nor in the same layer in all subjects.

The Vitreous body will be seen to fill four-fifths of the space within the coats of the eyeball, and reaches forwards external to the circumference of the Lens, nearly to the Iris: but is slightly hollowed in front to receive the Lens. In looking to the

* Or Chromic Acid.

† The water in which the Lens has been boiled will be opaque with Globulin. It will bring out the Fibres better if 1 per cent. of Sulphuric Acid be added, and the boiling be continued for five or ten minutes.

inside of the eye through the vitreous body, the surface of the Retina, as long as it remains properly supported by this 'body,' will be seen to be quite smooth, except at one spot, rather to the side of the axis of the eyeball, where the optic nerve expands, and the central artery of the Retina enters.

The Vitreous body in its Hyaloid membrane should now be removed in order to see the inner surface of the Nervous Tunic or *Retina* : *i.e.* the delicate, almost pulpy membrane, which—contains the terminal part of the optic nerve,—lies within the Choroid coat,—rests on the Hyaloid membrane of the Vitreous humor, and,—extends forwards nearly to the outer edge of the ciliary processes of the Choroid, where it ends in a finely indented border—*viz.* the *ora serrata.*

We do not find in the Eye of the Ox, nor indeed in the Eye of any Mammal, except that of Man and of the higher Quadrumana, the yellow elliptical spot in the axis of the eyeball known as the 'macula lutea' or yellow spot of Sömmerring.

The Retina is easily separable from the investing membrane next external to it, *viz.* the Choroid coat; and when this is detached, the outer surface will be seen to be rough or slightly flocculent, from the fine shreds or fragments of a structure at first called *Jacob's Membrane,* but which is now generally recognised as the columnar layer of the Retina.

To prepare the Retina for Microscopic investigation, the Student should take a perfectly fresh specimen and harden it by immersing it in Müller's fluid (consisting of $2\frac{1}{2}$ parts of Potassium Bichromate, 1 part of Sodium Sulphate, and 100 parts of Distilled Water) ; then he should make a mixture of bee's-wax and olive oil (equal parts), and pour these substances when melted (at as low a temperature as possible) round the piece of Retina from which the sections are to be cut; or place the piece of Retina (if flat), sandwich-fashion, between flat plates made of these same substances. By this means

the tissue is supported and held firm while the section is being made.*

A vertical section of the Retina should be made and examined under the microscope, when three layers or strata of dissimilar materials will be apparent, *viz.* 1. an external layer consisting of rods and cones, called the *columnar* layer (stratum bacillorum); 2. an intermediate or *granular* layer, made up of two collections of rounded and oval corpuscles separated by a clear striated internuclear space; 3. an internal nervous layer, made up of three distinct structures: (*a*) externally (*i.e.* adjoining the inner stratum of nuclei in the 'granular' layer) is a stratum consisting chiefly of nerve cells (the cellular stratum); (*b*) intermediately is a stratum of nerve-fibres directed forwards from the optic nerve, and terminating in the nerve cells on which they lie:—both these strata—the cellular and the nerve fibre—diminish in thickness concomitantly as they extend forwards from the middle of the back of the eye;—and, (*c*) internally, a limiting membrane (membrana limitans), which lines the inner surface of the Retina, separating it from the vitreous body.

* Retina of Calf or Pig, prepared by Klein's method. 1. Take a perfectly fresh eye, and pierce the Sclerotic and the Cornea with a needle in several places. 2. Place it in Müller's fluid for three weeks. 3. Cut the eye transversely into two portions. 4. Take the Retina out and place it in dilute alcohol for three to five days. 5. Place it in dilute ammoniacal solution of Carmine (carmine, 10 grains; strong ammonia, 30 minims; glycerine, 2 oz.; distilled water, 20 oz.; rectified spirit, ½ oz.) for twenty-four hours. 6. Wash it in water and place it in absolute alcohol for half to one hour. 7. Place it between two plates of wax and oil (equal parts) or paraffin, and make sections. 9. Mount in Dammar (a solution of Dammar resin in benzole).—*Rutherford*, in *Quarterly Journal of Microscopical Science*, N.S. xlv., January, 1872.

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